# PREPARING FOR AN OIL-LESS FUTURE: ENERGY, CLIMATE CHANGE AND GREEN BUSINESS IN ABU DHABI

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## ABSTRACT


**PREPARING FOR AN OIL-LESS FUTURE:**
**ENERGY, CLIMATE CHANGE AND GREEN BUSINESS IN ABU DHABI**

**Gökçe Günel, Ph.D**
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This dissertation project investigates the production of renewable energy and clean technology infrastructures in an oil-rich country, as the era of abundant oil supplies is slowly coming to an end. Its centerpiece is Masdar, a multifaceted renewable energy and clean technology company in Abu Dhabi, the United Arab Emirates, where I conducted nine months of ethnographic research between September 2010 and June 2011. I also pursued five months of fieldwork at the Technology and Development Program at Massachusetts Institute of Technology between January 2010 and May 2010, and conducted research with the United Nations Framework Convention on Climate Change (UNFCCC) office in Bonn in August 2011 and March and April 2012. Across these various sites, I interrogate the ways in which imaginaries of renewable energy and clean technology infrastructures are articulated and experienced both at a personal level and at the level of project management. By studying how emergent technology, knowledge, and governance on renewable energy and clean technology afford a potential reorganization of sociotechnical relations in an oil-rich country, I contribute to literature on oil and climate change, and to studies of energy transitions, sustainable urbanism,

technological imaginaries and knowledge production, as explored in fields of anthropology, science and technology studies and environmental studies.

In my dissertation, I track five projects undertaken by Masdar: (1) the construction of an eco-city, (2) the establishment of a clean technology and renewable energy research institute, (3) the creation of a new energy currency, (4) the implementation of a driverless electric personal rapid transport network, and (5) the production of a carbon capture and storage (CCS) policy proposal. I argue that these projects articulate an aspiration for the manageability of ecological problems, wherein business models are thought to contain and resolve climate change without surrendering hopes for increasing productivity and technological complexity. Yet such projects also reveal unresolved tensions between different infrastructures of technology, knowledge, and governance, resulting in a growing accommodation of contradictions within the renewable energy and clean technology sector—viz: a car-free eco-city surrounded by a parking lot of SUVs.

Through a close ethnographic investigation of these projects, I present a framework for analyzing how emergent technology, knowledge, and governance on renewable energy and clean technology come together to propose a reorganization of sociotechnical relations in an oil-rich landscape.

## BIOGRAPHICAL SKETCH

Gökçe Günel grew up in Istanbul, Turkey, and moved to the United States in 2007 to pursue her PhD in Anthropology at Cornell University. She holds a BA in Business Administration and an MA in International Relations from Koç University, Istanbul.

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Khaled Malas read every piece of writing that I drafted during the past five years, including this page, gave thoughtful feedback, and motivated me to carry this project forward when I felt it was least possible. I thank him for being there, despite long distances.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| ADCO | Abu Dhabi Company for Onshore Oil Operations |
| ADNOC | Abu Dhabi National Oil Company |
| ARDECO | Arab Development Establishment |
| AUB | American University of Beirut |
| BMS | Building Management System |
| CCS | Carbon Capture and Storage |
| CDM | Clean Development Mechanism |
| DECC | Directorate of Energy and Climate Change |
| EOR | Enhanced Oil Recovery |
| GE | General Electric |
| GDP | Gross Domestic Product |
| IEA | International Energy Agency |
| KAUST | King Abdullah University of Science and Technology |
| METU | Middle East Technical University |
| MIT | Massachusetts Institute of Technology |
| NYU-AD | New York University in Abu Dhabi |
| PRT | Personal Rapid Transit |
| R&D | Research and Development |
| SWF | Sovereign Wealth Funds |
| TDP | Technology & Development Program |
| UAE | United Arab Emirates |
| UN | United Nations |
| UNFCCC | United Nations Framework Convention on Climate Change |
| USAID | United States Agency for International Development |
| WFES | World Future Energy Summit |

# INTRODUCTION

## Renewable Energy and Clean Technology in an Oil-Producing Country

In this dissertation project, I explore the production of renewable energy and clean technology infrastructures within an oil-producing country, at a time when abundant oil supplies are coming to an end. In investigating the production of these emergent infrastructures, I specifically focus on Masdar, a multifaceted company that specializes in the development and commercialization of renewable energy and clean technologies in Abu Dhabi, the United Arab Emirates (UAE). At a time when the future of energy infrastructures remains a "technical uncertainty rather than determinism," I suggest it is crucial to keep in mind Timothy Mitchell's suggestion that "the building of solutions to future energy needs is also the building of new forms of collective life."[1] As such, I attempt to explore the implementing of technologies and knowledges at Masdar, simultaneously highlighting the experimental nature of the tools currently at hand.

In studying the establishment of Masdar, I argue that the emergent renewable energy and clean technology infrastructures strove to become "iconic." First, through its experimental infrastructures, Masdar sought to demonstrate the manageability of ecological problems, wherein business models would contain and resolve climate

[1] Mitchell, Timothy. 2011. *Carbon Democracy: Political Power in the Age of Oil*. New York: Verso, p. 238

change without surrendering hopes for increasing productivity and technological complexity. Second, these emergent infrastructures were to act as material manifestations of Abu Dhabi's engagements with mobilizing individual agency and formulating global strategy towards the resolution of environmental problems, culminating in the production of a knowledge-based economy. Through their high visibility, these novel infrastructures also strove to increase the Emirate's credibility and attract investments from outside parties, generating further capital growth.

By relying on nine months of ethnographic research I conducted with individuals who produced renewable energy and clean technology infrastructures within the UAE, in addition to five months of fieldwork with the Technology and Development Program (TDP) at Massachusetts Institute of Technology (MIT), and research trips to the United Nations Framework Convention on Climate Change (UNFCCC) office in Bonn, I interrogate how imaginaries of renewable energy and clean technology infrastructures were articulated and experienced both at a personal level and at the level of project management.

**Background on Masdar and Abu Dhabi**

Masdar is most widely known for Masdar City, a 'futuristic' eco-city that is master-planned by the architecture office Foster + Partners and that seeks to rely entirely on renewable energies for its energy demands. Yet it is also by investing in

renewable energy and clean technology via its other operations—Masdar Power, Masdar Carbon and Masdar Capital— that Masdar attempts to ensure Abu Dhabi will remain a significant player in the energy industry, even if its oil wells run dry. Masdar Institute, the energy-focused postgraduate research center that is set up and supervised by MIT's Technology and Development Program (TDP), currently operates in the only building amidst the construction site of the eco-city. Masdar has been put together by Mubadala Development Company, a state-owned corporation that targets economic diversification within Abu Dhabi, to act as a flagship organization for renewable energy and clean technology industries in the Emirate.[2]

[2] In the United Arab Emirates (UAE), the federal government has the responsibility to control areas such as foreign policy, security and defense, while the energy sector remains administered at the Emirate level. As such, each of the seven Emirates within the federation manages its own fossil fuel reserves, and controls the future of its energy sector. Mubadala Development Company, an Abu Dhabi owned company, differentiates itself by its emphasis on managing long-term capital-intensive investments that deliver not only financial returns, but also social benefits for the Emirate. Sheikh Mohammed bin Zayed bin Sultan Al-Nahyan, who is currently the Crown Prince of Abu Dhabi, next in line for UAE presidency after Sheikh Khalifa bin Zayed Al-Nahyan, acts as the chairman of Mubadala. Mubadala is the second largest corporation in the Emirate, following Abu Dhabi National Oil Company (ADNOC).

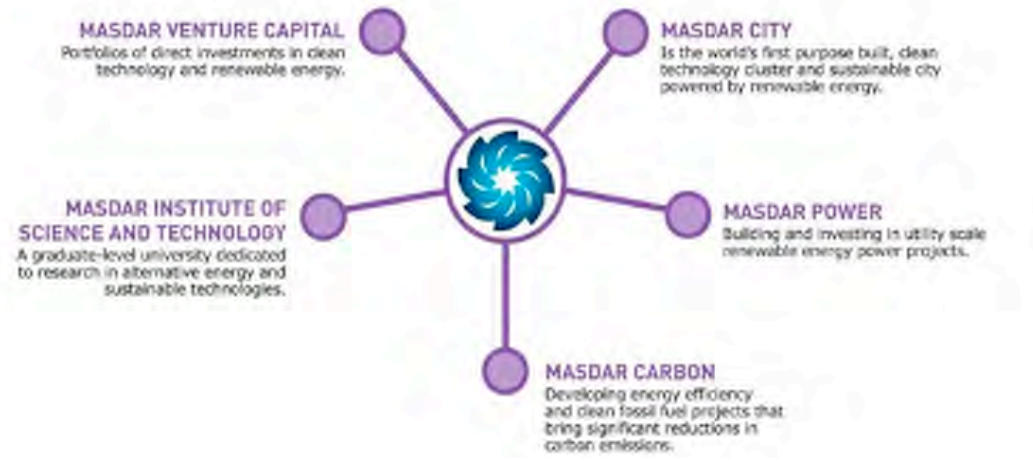


Figure 1 Current Organizational Structure of Masdar[3]

In the early 1960s, while still under British control, Abu Dhabi commanded around ten percent of the world's proven hydrocarbon deposits. However, under the rule of Sheikh Shakhbut, often remembered for not fully complying with British interests, Abu Dhabi refused development interventions.[4] But Sheikh Zayed, who came to power with British support in 1966, drastically transformed policies during his rule that lasted until his death in 2004, prioritizing oil concessions and contracts.[5] By the 1990s, the Emirate accounted for over 90 percent of the UAE's oil exports, and had the capacity to pump 2.5 million barrels per day, constituting what Michael Watts[6] calls an "oil complex."

[3] During a follow-up conversation in December of 2011, a research collaborator from Masdar Carbon pointed out that this organizational structure was in flux, and possibly changing in 2012.
[4] Zahlan, Rosemarie Said. 1978. *The origins of the United Arab Emirates: a political and social history of the Trucial States*. New York: St. Martin's Press.
[5] Davidson Christopher. 2009. "Abu Dhabi's new economy: Oil, investment and domestic development". *Middle East Policy*. 16 (2): 59-79.
[6] Watts, Michael. 2004. "Resource Curse? Governmentality, Oil and Power in the Niger Delta, Nigeria." *Geopolitics* 9(1): 31.

Michael Watts describes the oil complex as a unity of corporations, state and community set up within enclaves in which oil capital is an active presence. In such contexts, oil is a centralizing force that renders the state more visible, while simultaneously producing an undisciplined oil-led development that discredits the state. However, Abu Dhabi's attempts at adapting to possible oil depletion[7] by investing in renewable energy and clean technology infrastructures grant the Emirate further credibility both internally and in the international sphere. Although Abu Dhabi continues to rely on various networks of oil for expanding into the renewable energy and clean technology sectors, as one of my research collaborators suggested, the practices adopted in promoting renewable energy and clean technology infrastructures, such as setting up a research institute, entering joint ventures with environmentally conscious utility companies, or investing in an eco-city, render the Emirate "more elite."

These environmental strategies should indeed be understood in the context of mechanisms that seek to regulate and promote international finance, technology transfers, or development efforts. Yet seeing them as mere continuations of an existing apparatus is to underspecify the novel infrastructures of technology, knowledge and governance, which elicit new tensions in the contexts they manifest themselves. Drawing upon ethnographic research, I provide a framework for

[7] Davidson Christopher. 2009. "Abu Dhabi's new economy: Oil, investment and domestic development". *Middle East Policy*. 16 (2): 59-79.

understanding how such emergent infrastructures are interlaced to produce imaginaries of renewable energy and clean technology as future business enterprises within an oil-rich country, contributing to literature on oil and climate change, and to broader discussions on energy transitions, sustainable urbanism, technological imaginaries and knowledge production.

**Iconic Infrastructures of Energy**

"Iconic for us," Mr. Awad, a former executive at Masdar, said, "means environmentally friendly and sustainable," as he provided information on the upcoming Masdar City buildings to the English-language United Arab Emirates newspaper, *The National*.[8] According to Mr. Awad, Masdar City, a hub for renewable energy and clean technology, would house several iconic structures, including the currently existing Masdar Institute campus. But it was important to Mr. Awad that the meaning of "iconic" would thereafter change, having to include an "environmentally friendly and sustainable" component. This was the key to the infrastructures of technology, knowledge and governance that Masdar was preparing to showcase to the rest of the world.

This discursive transformation may be important in figuring out how and why the renewable energy and clean technology infrastructures at Masdar were somewhat

[8] http://www.thenational.ae/news/uae-news/environment/progress-is-on-track-at-masdar-city Last accessed March 17, 2012

different from pipelines, highways or communication wires; infrastructures that, unless they malfunction, remain rather invisible. Through their emphasis on "environmentally conscious and sustainable" principles, the iconic infrastructures seemingly promised an alternative "mark of progress,"[9] which would resolve pressing energy defiency and climate change related problems. In this sense, Masdar, as a formula for overcoming upcoming crisis of energy deficiency and climate change, was grounded on "a utopian belief in the possibility of an unending technological progress, and an everyday life structured around the technological infrastructures." [10] In an environment afflicted with climate change and energy deficiency, the proposed renewable energy and clean technology infrastructures would serve as spaces of hope. Accordingly, the future would be imagined only in dialectical extremes, both as hell and as heaven, as catastrophe and dreamworld.[11] Conceptions of the approaching end of the world would be complemented with imaginaries of a utopian future, driven by a coming together of vernacular forms and experimental technology.

In line with this understanding, an architect from Foster + Partners, the architecture office responsible for the Masdar City master-plan, presenting at a panel on Eco-Cities in New York City in February of 2009, started his slideshow with a diagram illustrating the disappearing species of the world. He argued that the world

[9] http://www.thenational.ae/news/uae-news/environment/masdar-city-is-a-mark-of-progress Last accessed March 18, 2012

[10] Masco, Joseph. 2006. *The nuclear borderlands: the Manhattan Project in post-Cold War New Mexico*. Princeton, N.J.: Princeton University Press, p. 1

[11] Buck-Morss, Susan. 2000. *Dreamworld and catastrophe the passing of mass utopia in East and West*. Cambridge, Mass: MIT Press.

was transforming drastically, and that humanity had to be quick in determining a course of action. In the next few slides, Masdar City, an eco-city that seeks to combine vernacular Arabic architecture with state of the art technology, appeared as the panacea to the problems he underlined. Through such means, the architect, as well as the other presenters at this sustainable urbanism panel, simultaneously crafted apocalyptic understandings and utopian imageries – two interdependent gestures towards the future.

But what if the utopia or science fiction, often used interchangeably by my interlocutors, did not work? What if it did not live up to its promises? The producers of the city did not know if there would be enough funding for it to be completed, the subcontractors could not estimate how long they would work on the compound, and the researchers wondered if they could receive data regarding the eco-city for their planned publications. At the same time, meetings were continuously postponed, completion dates were repeatedly delayed, and things seemed to always malfunction. And yet, the perception of these fragilities was not always shared amongst the parties that participated in the making of the project.

In fashioning future scenarios, some of my interlocutors referred to the Personal Rapid Transit (PRT) network, which was planned and heavily advertised but later dropped due to financial concerns. The PRT thereby served as a metonymical device, driving towards what could possibly happen to Masdar City. In this framework, Masdar City could transform into an amusement park, in the same way

that the pilot PRT line between the parking lot and Masdar Institute became reconstituted as an "expensive toy" by some of the city's frequenters (chapter 4). Others suggested that Masdar could give up its ambitions to be an eco-friendly city, and re-define itself as a clean technology cluster, a tax free zone where all renewable energy and clean technology companies would congregate (chapter 3). Would Masdar City ever be built, many of my interlocutors wondered, or would it ever be 'finished'? Like perceptions of disintegration, failure and incompletion, the responses to these questions were never shared and far from uniform.

Framed as a utopia or science fiction project, which would sooner or later be completed, Masdar City needed the backdrop of a world struck by climate change and energy deficiency. The marketing and communications campaigns put together by Masdar aimed at proving that the opposite was also true – that the world needed Masdar City.

**Imperatives of Iconic Infrastructures**

The utopian or science fiction function of the iconic infrastructures would not remain confined to the provision of renewable energy. In addition to providing an enclosure, first, the iconic infrastructures were expected to mobilize individual agency in a manner that conforms to the apocalyptic emergencies immediately at bay. Second, the infrastructures would enact a global strategy, and pave the way for Abu

Dhabi's economic transformation, specifically by assisting in the production of innovation, and generating credibility for the Emirate. Both of these gestures – mobilizing individual agency and formulating global strategy – would be facilitated through the commitment of the authoritarian state, a condition often perceived as a privilege by my interlocutors. Both of these gestures would attempt to build relations and collectivities around the ideas that they propagated.

The engineering of emergent infrastructures simultaneously meant the production of "systems whose design features mattered fundamentally to their success and shaped the ways in which those systems acted upon the world."[12] Accordingly, through their aesthetic and technical qualities, the infrastructures mobilized individual agency amongst those frequenting Masdar, who would, in the long run, learn how to cope with the demands of complex mechanisms of energy efficiency. Through the emergent infrastructures, ranging from energy currency schemes (chapter 3) and personal rapid transit systems (chapter 4) to policy instruments (chapter 5), researchers, students and professionals affiliated with Masdar would become re-fashioned as environmentally conscious individuals, and conform to the routines of a permanent emergency (chapter 2). The adoption of such new technologies would also bond the people working at Masdar, reorganize aesthetic and technical

[12] Hecht, Gabrielle. 2011. *Entangled geographies: empire and technopolitics in the global Cold War*. Cambridge, Mass: MIT Press, p. 3

expectations,[13] and recreate them as a collectivity. Learning how to function within the seemingly complex infrastructures of energy would be, as one of my interlocutors suggested, like learning "table manners."

Moreover, the iconic infrastructures of energy constituted a political and economic strategy with global reach, forming the backbone of Abu Dhabi's transformation from a resource-based economy into a knowledge-based model. In the inaugural meeting of the Masdar Institute board of trustees, it was reported, "Sheikh Mohammad [the incumbent Crown Prince of Abu Dhabi] expressed his great confidence in the Masdar Institute, noting that it is integral in supporting the national vision to transform Abu Dhabi into a knowledge-intensive economy, providing mankind's urgent need for clean energy and sustainable development and in increasing the overall intellectual capital of the region by creating excellent educational institutions."[14] Accordingly, such emergent infrastructures, as exemplified by beautiful buildings or research contracts (chapter 2), served as strategic artifacts towards the implementation of clearly depicted political and economic objectives in the United Arab Emirates, and constituted preparations for a time when oil exports would no longer satisfy Abu Dhabi's needs. "We must continue our efforts and retain

[13] It is important to remember that these practices did not exorcise the boundaries between immigrant workers, preparing meals, serving tea or working as construction workers in the building, the expatriate professionals, employed in different units of the corporation, and the Emiratis. Immigrant workers, though not a unified category in themselves, were left out of most experiments. Rather than taking the PRT, for instance, they were required to take a shuttle bus to the parking lot outside the Masdar Institute building. In other words, they were not invited to benefit from the "table manners," which other expatriate workers and Emiratis were expected to acquire.

[14] http://gulfnews.com/news/gulf/uae/education/masdar-institute-is-key-to-knowledge-based-economy-1.141627 March 21, 2012

the same passion and determination and vision to face future challenges, even if our resources of energy buried underground were to fall or dry up," Sheikh Mohammed emphasized.[15] As "a hub of renewable energy and clean technology,"[16] Masdar was of critical significance in realizing this vision of the future.

In the institution of extensive infrastructural projects, intermittent financing may become a significant challenge. However, in the case of Masdar, the authoritarian and therefore "infrastructure-friendly" government[17] often served as a steady source of financing for the initiative. Accordingly, the producers of Masdar celebrated the commitment that the state demonstrated in funding the project. Without such a dedicated provider of financial resources, they frequently reminded me, a project of such scale would never be realized (chapter 1). In addition to being a dedicated source of finances, the authoritarian regime was perceived as a useful backdrop for the growth of a knowledge-based economy. "When handling experiments with smart grids for instance," an MIT professor told me, referring to the energy currency system that was being formulated inside Masdar City (chapter 3), "it is impossible to receive permissions in the United States. But in the UAE, we can run such experiments. That's one of the reasons why we would like to collaborate with

[15] http://www.thenational.ae/news/uae-news/environment/masdar-city-is-a-mark-of-progress Last accessed March 21, 2012
[16] http://www.masdarcity.ae/en/ Last accessed April 10, 2012
[17] For an exploration of the relationship between authoritarian regimes and infrastructure building, see: Trischler, Helmuth and Hans Weinberger. 2005. "Engineering Europe: big technologies and military systems in the making of 20th century Europe," *History and Technology*, 21(1): 49-83, p. 57

the Abu Dhabi authorities." As such, for many of my interlocutors at Masdar, authoritarian rule transformed into a desirable condition where permissions were granted, producing a steady flow of financing, in addition to unique research opportunities.

The authoritarian rule proved to be a problem though, whenever the emergent infrastructures malfunctioned. Having dedicated so much to the project, the Abu Dhabi authorities wanted to see the infrastructures work. One of my interlocutors expressed how difficult it was to convey criticism to the CEO of Masdar, an Emirati national rumored to be close to the government. "If he says that it works, it works. You cannot argue with it," he added. "But when you're in denial about something, you can never really fix it, so the problems with the project keep lingering on without any real resolution," he concluded, and underlined how certain commentators and visitors had already become aware of this irony (chapter 1). "The UAE is not interested in completing their projects," another research collaborator criticized developments at Masdar, "for them, what really matters is to be on the map." In this way, she emphasized that the representation of projects was more significant to the Abu Dhabi authorities than the actual functioning of the projects themselves. Once again, these comments emphasized how variable understandings of failure, incompletion and disintegration were on the Masdar City construction site.

On the other hand, the Abu Dhabi government believed that through such committed financing of renewable energy and clean technology projects, they would

demonstrate their dedication to this experimental infrastructure, gain credibility, and thereby attract investments from third parties (chapter 2). Yet in some sense, the failure, incompleteness or disintegration of the projects did not seem to matter that much. As the PRT example demonstrated (chapter 4), the emergent infrastructures would instigate the formation of relations and collectivities even when they malfunctioned, or were scaled back and cancelled. They could perform a particular relationality in representation form as well, thus making the material production of the infrastructures somewhat secondary. In this framework, what counted most appeared to be the new types of connections that Abu Dhabi formulated thanks to its engagement with these new technological systems. For this economic vision to work, Abu Dhabi had to rework its oil-based relationships into knowledge-based ones, even if the parties that it cooperated with remained the same. As such, the characteristics of the relationships seemed to matter more than which groups the relationships were forged with.

Through projects like Masdar, a marketing department representative explained to me, Abu Dhabi managed to preserve the legacy of Sheikh Zayed, the founding father of the UAE, and follow his perceived commitment to a green environment. On the other hand, a faculty member at Masdar Institute suggested that the Sheikh Zayed legacy, and such romanticized notion of being one with nature, were actually an impediment for the adoption of sustainability in the country. "It's as if when you mention the Sheikh Zayed legacy, you automatically become green, so you don't really

have to do anything about it, you don't have to change your behavior," she underlined. While for the marketing department, "the Sheikh Zayed legacy" appeared to be an incentive for the UAE to engage with environmental projects, for others it was almost a setback, through which the Abu Dhabi residents legitimized their often-wasteful practices. But perhaps at the representational scale the argument about Sheikh Zayed's legacy did work, framing Abu Dhabi's investments in initiatives like Masdar as ritualistic reverences to the founding father of their nation-state.

In addition to following the Sheikh Zayed legacy, Abu Dhabi hoped to transform its "brand image" through projects like Masdar, inducing a "perception shift," thereby attracting foreign investments to the Emirate. "In 2005, Abu Dhabi was perceived to be a high polluter, and was heavily associated with hydrocarbon consumption and exports," a marketing department employee told me. But now, through Masdar, and other initiatives like the World Future Energy Summit, an annual trade show dedicated to renewable energy and clean technologies, Abu Dhabi seemed to be at the forefront of the emergent renewable energy and clean technology infrastructures. "We have also conducted a "top of mind" survey," she added, without giving much information regarding the survey respondents, "these days if you think renewable energy, you think Masdar." As such, she evidenced how the intended transformation was already underway.

**Contribution to Literature on Oil and Climate Change**

In literature on oil wealth and networks, it is argued that conceptions of endless oil supplies enabled progress to be conceived as infinitely expandable, and without any material constraints. How then do oil economies prepare for oil-less futures? In this project, I emphasize that Abu Dhabi capitalizes on the existing networks and wealth that its current oil production makes available in order to construct a post-oil economy – showing how in coping with the possible end of the era of abundant oil, it physically and socially constructs knowledge of renewable energy and clean technology as an alternative resource.

Moreover, I suggest that perceptions of climate change shape and become reshaped by the social context in which they are interpreted. I focus on the tensions between infrastructures of technology, knowledge and governance to develop how these co-productions may be seen as fruitful moments of unresolved indeterminacy and possible reconfiguration. Contributing to literature in anthropology, science and technology studies, and environmental studies on the ways in which scientists, politicians, corporate actors or indigenous populations respond to environmental problems, my ethnography of renewable energy and clean technology infrastructures investigates how climate change becomes reinterpreted, circulated and utilized by oil-rich nations, highlighting the influence they exert on the global sociopolitical order.

All in all, in this project I seek to foreground how the emergent energy infrastructures, here demonstrated by an eco-city, a personal rapid transit system, an

energy currency, an energy-focused research institute and a carbon capture and storage policy proposal, will be significant in shaping social, political and economic relations in upcoming years.

**Outline of Chapters**

In this dissertation, I track five projects undertaken by Masdar: (1) the construction of an eco-city, (2) the establishment of a clean technology and renewable energy focused research institute, (3) the creation of a new energy currency, (4) the implementation of a driverless electric personal rapid transit (PRT) network, and (5) the production of a carbon capture and storage (CCS) policy proposal. I argue that these projects often spawned an aspiration for the manageability of ecological problems, where developments in business and technology would advance solutions for climate change without compromising economic returns. Such projects also sought to mobilize individual agency within Abu Dhabi, while formulating global strategy for attracting investments into the Emirate, and thus contributing to the production of a knowledge-based economy.

I start my dissertation by focusing on the construction of Masdar City, perceiving that its construction site sheds new light on what the advocates of the project have already underlined through their promotional enunciations. While I document and examine the discursive functions and visionary content of press releases, corporate presentations, videos and flyers, and other marketing and

communication devices, I substantiate my mappings and analyses of these instruments with formal and informal interviews and participant observation among different groups, such as the diverse student community in Masdar Institute that wrestles with the tribulations of studying in an experimental green building, or on-site architects who are developing the Masdar City master plan. My interlocutors comprise individuals with global experiences, having grown up and worked in different countries. Through them, I encounter a multiplicity of reflections on how the renewable energy and clean technology industry in Abu Dhabi is conceived, and how the discourses of climate change are incorporated into it. In doing so, I foreground the significance of the personal level in the production of renewable energy and clean technology infrastructures. Examining the imagery used in defining and describing Masdar City, I argue that such conceptions situated the eco-city project in a bounded space and in a utopian or science fiction time. While showing how at Masdar City, the present was full of activity, I point to the ways in which the imagery utilized in framing Masdar City consistently formulated the present as a vacated category, and located the city in a perpetual future.

Along with an eco-city for 50,000 people, Masdar concentrated its resources in the establishment of a renewable energy and clean technology institute. Accordingly, in June of 2011, about eighty students from around the world completed MSc degrees

at Masdar, having studied replicas of degree programs at MIT.[18] As the first alumni, they stated that they had been subjects to the experiment of building an eco-city. On the other hand, the UAE government, which offered full scholarships to all enrolled students, expected they would stay in the country, contributing to a knowledge-based economy around clean technology and renewable energy, in the same way MIT graduates helped create Boston 128. In this chapter, I benefit from interviews with on-site architects, students, faculty and administrators at Masdar and archival and ethnographic work at MIT's Technology and Development Program to study Masdar Institute as a node that may transform the UAE by producing knowledge on renewable energy and clean technology. In doing so, I concentrate on 'beautiful buildings' and 'research contracts,' which were the main means through which such relationality would be established, facilitating the emergence of an economy of innovation.

Besides helping implement the UAE's economic vision, Masdar Institute attempted at engineering an economic vision of its own, specifically by planning a new energy currency. Masdar Institute faculty members, for whom I worked as a research assistant, imagined that in the future, inhabitants of Masdar City could be issued a balance of energy credits called "ergos," as a means of defining and regulating their pre-allocated energy budget. Through individual monitoring and regulation, ergos

[18] Masdar Institute currently offers the following programs: MSc in Chemical Engineering, MSc in Computing and Information Science, MSc in Electrical Power Engineering, MSc in Engineering Systems and Management, MSc in Materials Science and Engineering, MSc in Mechanical Engineering, MSc in Microsystems Engineering, and MSc in Water and Environmental Engineering.

aimed at decreasing energy consumption amongst the residents of Masdar City. And yet even the researchers that I worked with occasionally mentioned that the ergos project had a "Big Brother side" to it, and that it could lead to a "technocratic dictatorship." Relying on meetings with faculty, post-doctoral researchers, students and engineers from Masdar, and interviews with representatives from Schneider Electric, the project subcontractor, I show that in planning ergos other layers of systems, such as new building automation systems or smart electric meters, had to be installed, and underline the frictions between them. I argue that these everyday frictions, in addition to the abstract understanding that the project would eventually serve a higher good, enabled the researchers to continue with their work, despite their concerns regarding a potential "technocractic dictatorship."

Another artifact that attracted much attention to the construction site of Masdar City was the driverless electric personal rapid transit (PRT) pods, offering automated transportation for groups up to six people between two points on a network. While the PRT was envisioned to connect the entire eco-city, such plans were dropped in late 2010 due to financial challenges. Still, there was one destination that passengers at Masdar Institute could travel to – the parking lot outside the building. The ten pilot PRT vehicles completed around 250 trips per day, attracting many visitors to the site due to their futuristic design. The PRT also comprised a central debate amongst my interlocutors, leading some to designate it a victory, while leaving others more skeptical regarding its capacities. At the same time, others who

experienced the PRT wondered why bicycles or simply walking were not utilized in this short distance, at times calling the experimental transportation device "an expensive toy." The recurrent breakdowns resulted in complaints, facilitating discussions on how central technoscientific experimentation should be in adopting sustainability goals. In this chapter I draw upon participant observation with individuals frequenting Masdar Institute, such as students, faculty, architects, visitors, and professionals from other units of Masdar, in addition to interviews with representatives from 2getthere, the PRT subcontractor to interrogate what failure or success means for the PRT project. Understanding the short PRT line between the Masdar Institute building and the parking lot as a productive ethnographic object, I argue that the pilot PRT triggered the formation of multiple collectivities, perhaps constituting an accomplishment.

In my final chapter, my ethnography descends underground. Here, I follow policy-making on CCS, a controversial climate change mitigation technology that operates by obtaining carbon dioxide from industrial compounds, carrying it to storage sites, and injecting it into the ground. By injecting carbon dioxide into fields and forcing oil out, oil-producers may extend the lifespan of oilfields. It is also argued that CCS may cause the leakage of concentrated amounts of carbon dioxide, and liability protocols related to such incidents remain lacking. I study the preparation for a CCS policy proposal for the UNFCCC by representatives from Abu Dhabi Company for Onshore Oil Operations, Abu Dhabi National Oil Company, Ministry

of Foreign Affairs, and the consulting body Masdar Carbon, where I worked as an intern. By observing meetings, and interviewing policy-makers and UNFCCC employees, I lay out how participants translate across their zones of professional comfort, how business plans and government policy work at odds, and how national policies are crafted through negotiations with multinational oil companies. I thus provide insights into the backstage of climate change governance.

By studying how emergent technology, knowledge and governance on renewable energy and clean technology propose a potential reorganization of sociotechnical relations in an oil-rich country, I contribute to literature on oil and climate change, and to studies of energy transitions, sustainable urbanism, technological imaginaries and knowledge production, as explored in fields of anthropology, science and technology studies and environmental studies.

## CHAPTER ONE:

## CONSTRUCTING MASDAR CITY

### The Idea

"I came up with the idea of founding Masdar City," Mazen, then an executive with Masdar, forthrightly said. Mazen, a Lebanese national, had been working in Dubai as a consultant for some years,[19] and was convinced that green businesses would soon explode. With this projection in the back of his mind, he organized a meeting with government officials from Qatar, the richest of the Gulf countries. It is unclear whether he outright suggested that they should build an eco-city, but he did insist on how crucial and timely it was to invest in clean technologies and renewable energy. Nevertheless, he could not make the Qatari officials too interested. "Abu Dhabi has always been the most visionary of the Gulf states," Mazen said. "It's not unusual that they liked the idea, and pursued it immediately." This must have been 2004. Masdar, meaning 'source' in Arabic, was officially started in May 2006.

In this chapter, I seek to focus specifically on the imagery that was utilized in speaking about Masdar City in the years that followed the launching of the project. In this way, I strive to explore the spatial and temporal discourses and mechanisms that

[19] As one of my research collaborators clarified in an e-mail message, Mazen had two partners in this Dubai consultancy. The three partners had come up with the idea of starting Masdar together, and organized the meetings with government officials in Qatar and Abu Dhabi, and they had all joined Masdar as executives. However, in 2009 and 2010 respectively, Mazen's two partners had left Masdar, and started a new company. An interview with one of Mazen's partners on how the emergence of the Masdar idea is available here: http://www.greenprophet.com/2012/01/masdar-ziad-interview/ Last accessed March 2, 2012

were utilized in planning and building the eco-city. Why and how did Masdar become conceptualized as a city of the future, and what did it mean for the project to be located at an other time, in addition to being located within a bounded area in the desert, often conceptualized as an other space? What, or perhaps when, was the future imagined through Masdar City? I study how the students, architects or executives who were involved in the production of Masdar related to the futurity of the city, and inquire how and if they shared the utopian aspirations that were part and parcel of creating its image. How did they understand the labor towards producing a green city in the middle of the desert within an oil-producing country? Accordingly, I examine how students, architects, or executives imagined a technologically enhanced space that did not yet exist within a present in which they could not be hold fully accountable for their projections. I finally attempt to contextualize Masdar's strategies within a framework of major renewable energy and clean technology companies. Consequently, I show how the present becomes a vacuous category in regards to the efforts for implementing renewable energy solutions, with a stark dependence on an abstract, idealized and perpetual future.

Articles on Masdar City began appearing in the international press right after the official launching of the project. "Abu Dhabi, the capital of the United Arab Emirates, the fourth largest OPEC oil producer with about 10 percent of the known reserves, is seeking to become a center for the development and implementation of

clean-energy technology," a *New York Times* article announced.[20] The zero-carbon district would cost $22 billion, and eventually house 50,000 people and 1500 businesses. Masdar claimed that it would implement a personal rapid transport (PRT) network throughout the city, thus completely prohibiting car entry (see chapter 4). The efforts to start a renewable energy focused post-graduate research institution at the center of the city by bringing in Massachusetts Institute of Technology (MIT) were also publicized by Masdar's marketing department, with the promise that this institute would serve to transform Abu Dhabi into a next Boston 128, in the same way that MIT transformed the Boston area into a start-up haven (see chapter 2). Together with other satellite campuses, such as New York University in Abu Dhabi (NYU-AD) or Sorbonne, Masdar Institute would carry a significant role in instituting a knowledge-based economy in Abu Dhabi. While some commentators mocked the project for being located in a country where carbon footprint per capita is the highest in the world, others appreciated the fact that an oil-rich Emirate was investing in renewable energy resources, thereby acknowledging that the energy portfolio of the future would not only consist of fossil fuels. During the groundbreaking ceremony, Sultan Al Jaber, the CEO of Masdar, declared, "We are creating a city where residents and commuters will live the highest quality of life with the lowest environmental footprint. Masdar City will become the world's hub for future energy. By taking

[20] See: http://www.nytimes.com/2007/03/18/world/middleeast/18abudhabi.html?pagewanted=all Last accessed December 22, 2011

sustainable development and living to a new level, it will lead the world in understanding how all future cities should be built."[21] This is how the future of Masdar City started being marketed, initially.[22]

**An Enclosed Space**

The United Arab Emirates government had designated the construction site of the eco-city to be a 6-km2 area by the airport, a roughly twenty-minute car ride from Abu Dhabi proper. Prefabricated buildings which would house the professionals working with Masdar would soon be set up there, allowing everyone to have a sense

[21] See: http://www.masdar.ac.ae/inc/7/details.php?type=news&id=60 Last accessed December 22, 2011

[22] The literature on the building of cities from scratch has at times touched upon this futurity. "Ciudad Guayana as an entity exists only in the publicity flyers of the development agency," Lisa Peattie writes, in reviewing the emergence of Ciudad Guayana; a new city that was started in the 1960s, when the Venezuelan government invited planners from MIT and Harvard to create an emergent area of growth in the south of the country. "The design focus," Peattie continues, "served to convert the city into a kind of monument to the idea of progress, an ideological construction within which private gain could be thought of social progress and the general good." This emphasis, according to Peattie, was thought to possibly facilitate the emergence of an undivided community, while at the same time attracting investment and technically capable individuals to the city. In the case of Masdar, the eco-city would bring together a community of researchers, investors and professionals working on clean technology and renewable energy infrastructures, thereby functioning as a magnet for investments and technically capable individuals. Through this emphasis on innovation, the eco-city set a stark contrast to the resource-led economy of Abu Dhabi. In discussing the construction of Brasilia, James Holston also suggests, "This utopian difference between capital [Brasilia] and nation meant that the planning of Brasilia had to negate Brazil as it existed. Thus the Master Plan presents the founding of the city as if it had no history…On inauguration day, [the government] planned to reveal a miracle: a gleaming city, empty and ready to receive its intended occupants." This strategy worked for the construction phase of Brasilia. And yet, despite the attempts by the Abu Dhabi government to utilize what James Scott calls "high modernist" principles and practices in building a city, these plans could not be put to use within the eco-city. The economic downturn of 2008-2009 had prohibited Abu Dhabi from completing the construction of the city fully, demanding that Masdar City be built step by step, together with the investors that it sought to attract. A sustainability code was put together so that the investors would abide by the city's guidelines, even if they do not settle within gleaming and empty green buildings. Companies such as Siemens, BASF, General Electric and Bayer at once agreed to build within the clean technology cluster. See, Peattie, Lisa Redfield. 1987. *Planning, rethinking Ciudad Guayana.* Ann Arbor: University of Michigan Press. Holston, James. 1989. *The modernist city: an anthropological critique of Brasília.* Chicago: University of Chicago Press, and Scott, James C. 1998. *Seeing like a state: how certain schemes to improve the human condition have failed.* New Haven: Yale University Press.

of the on-going construction efforts. Masdar Institute, the post-graduate research institution set up by MIT, started its first projects in makeshift laboratories at Abu Dhabi's Petroleum Institute, waiting for its on-site eco-friendly building to be completed. In the meantime, Masdar organized a competition, inviting prestigious architecture offices, and selected Foster + Partners to be in charge of the master-plan design. During this period, Masdar also flew in flocks of consultants to initiate the project, study the site, determine how to structure the company, or explore potential partnership opportunities with multinational corporations. Masdar City, an eco-city that satisfies its energy demands through renewable energy sources thereby emitting no carbon dioxide, was going to be the first of its kind.

Very soon, digital renderings of the eco-city became available for public consumption. Videos showing what the city would look like circulated around the Internet quite extensively. "Imagine, imagine a place where the challenge of living in an extreme climate is overcome at no cost to the environment. Imagine a place of the future with all of the benefits of twenty-first century living, yet none of the stresses of outdated twentieth century cities," one video said. "Masdar City in Abu Dhabi is an emerging global clean technology cluster located in what aims to be one of the world's most sustainable urban developments, powered by renewable energy," another video suggested. Explaining how, "The city is anchored by the Masdar Institute of Science and Technology, which will be the center of original thinking that pushes the boundaries in fields of alternative energy, environmental technologies and

sustainability," and positing that "Masdar Institute forms the nucleus of the research and development community in the city…[T]he building design draws inspiration from traditional Arabian architecture whilst utilizing cutting edge technology to minimize energy consumption and carbon footprint," the video provided a first digital glimpse into how Masdar was imagined. "Masdar City is the city of the future and the role model for the world. Masdar City: One day all cities will be built like this," the video ambitiously concluded, and received mixed reactions.[23]

Figure 2 A Widely Circulated Digital Rendering of Masdar City

[23] See video: http://www.masdarcity.ae/en/49/resource-centre/video-gallery/?vid=1 Last accessed December 22, 2011

Many who reviewed the marketing and communications campaigns portrayed the project as "science fiction," and referred to films or novels that the city reminded them, such as Ridley Scott's *Blade Runner,* Paul Verhoeven's *Total Recall*, Luc Besson's *Fifth Element*, or Margaret Atwood's *Oryx and the Crake*. Situated in undefined futures, and within bounded cities where life proved impossible outside technologically supported zones, these works were perceived as good analogues to Masdar City. These portrayals also pointed to how, in Masdar's imagined future, the world would be struck by climate change and energy deficiency, demanding life to be sequestered within spaces such as Masdar City. In this framework, the time and space of Masdar City was perceived to be apocalyptic and utopian at once.

And yet, when executives working with Masdar City utilized these analogies, they received tongue-in-cheek criticism from reviewers. For instance, when explicating the personal rapid transit (PRT) system which was expected to be put in place inside Masdar City, one engineer working with the subcontractor construction company argued,[1] "You program what station you want to go to, and [the vehicle] will directly take you to that station...If you look at things like *Blade Runner*, etc., that we had 15 years ago, it's really bringing that to the fore now." In response, an environmental news website wrote,[1] "Masdar City is bringing *Blade Runner* to the fore? No one wants to live in a city full of replicants, even if it's eco-friendly. Someone better call Deckard to fix this mess before it gets out of hand." In this way, the news website reminded the executive how these works of science fiction, such as *Blade*

*Runner*, were critiques of totalizing environments, where, despite extensive rational planning, large-scale social problems proved to be inevitable. In other words, the executive was given a warning – *Blade Runner* was not something a developer should have wished to replicate.

According to the first digital renderings, the city would be surrounded by a wall, which would insulate it from desert winds and sand. In addition, densely populated narrow streets and shaded walks would decrease the need for air-conditioning by reducing the direct sunlight that the city would be exposed to. At the same time, solar panels located on the roofs of the buildings would generate enough electricity for the whole city, powering driverless vehicles used for public transportation. Fascinated with the technological devices, some suggested that at Masdar City, human sweat and other ambient moistures would be "plucked out of the air" and recycled into drinking water.[24] The project was thereby described as a "desert utopia," "a high-tech oasis," or "a city of the future" wherein previously unimagined technologies would terraform the barren landscape as a space of experimentation. One of my research collaborators, an engineering professor at MIT, provocatively stated that Masdar was "the only utopia to emerge from the Middle East since Islam." All in all, Masdar received attention. Many professionals who worked at Masdar's

[24] http://www.asylum.com/2010/04/22/UAE-Dubai-sustainable-carbon-neutral-masdar-city-abu-dhabi/ Last accessed January 24, 2012

various departments argued that the company's marketing budget was much larger than its other investments.

When the first phase of the Masdar Institute campus, an initial representation of what Masdar City attempted to achieve, was finally finished in September 2010, it became the first building to ever be reviewed on the front page of *New York Times*, one on-site architect told me. In the review, Nicolai Ouroussoff, the architecture critic with the newspaper, called the city a "futuristic playground for the rich," and stated that its design "reflects the gated-community mentality that has been spreading like a cancer around the globe for decades," and pointed to how, "Its utopian purity, and its isolation from the life of the real city next door, are grounded in the belief — accepted by most people today, it seems — that the only way to create a truly harmonious community, green or otherwise, is to cut it off from the world at large."[25] In response to the article, an on-site architect suggested that as designers they wanted the eco-city to be contained, specifically because they did not want to further instigate urban sprawl in Abu Dhabi, and added, "But that does not mean the city will not impact the rest of Abu Dhabi positively." Another on-site architect wondered how there could ever be a city that did not allow car entry, and still remain connected to the rest of the city grid, echoing Ouroussoff's critique.

[25] http://www.nytimes.com/2010/09/26/arts/design/26masdar.html?pagewanted=1&_r=1 Last accessed January 21, 2012

Soon after, a review was published in the *Observer* newspaper, in conversation with the *New York Times* article. "The Masdar plan has been accused of being gated and exclusive. It is not, although there is something spooky in the controls it employs in the name of the environment – a touch of eco-Orwell or at least eco-Huxley," the architecture critic Rowan Moore wrote, "[T]he purpose of the institute is to study the effectiveness of Masdar's techniques, so that they can be applied elsewhere." Moore seemed to understand spatial isolation to be an essential condition, as it would produce the necessary environment for experimentation, thereby allowing the city to truly influence, or rather create, the future. From this isolation, a new generation of research and business would emerge, which would shape the energy infrastructures of a world without fossil fuels. In this understanding, Masdar City had to be an enclosed space, where the future would be incubated.

**The Fiction of Shibam**

On November 10th 2010, about two months after the students and faculty moved out of the Petroleum Institute to resume their studies in the new Masdar Institute building, Daniel, the Foster + Partners architect in charge of the Masdar City master plan, gave a presentation on Masdar City. He started the slideshow by referring to cities that have employed design principles akin to Masdar, relying on features such as narrow streets, the shading of windows, courtyards and wind towers.

The audience, which mainly comprised Masdar Institute students, listened carefully. "We have learned from old Arab cities in designing Masdar," Daniel said, "for example, Shibam in Yemen." A second-year student, who had heard of this reference before, immediately raised his hand to ask a question. "But does Shibam really exist? Have you ever seen it?" Daniel replied that it was too dangerous to travel to Yemen these days, so he had never been to Shibam, and added how he would love to go there someday. This city, or this historical artifact as Daniel framed it, had been one of the primary inspirations for building Masdar City, an eco-city that strove to be located in the future.[26] According to Daniel's presentation, Masdar took its roots in a uniquely Arab past; a past still evident in cities like Aleppo and Fez, a past herein expressed with the pseudo-imaginary city of Shibam.[27]

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[26] In his book *Dubai, the city as corporation*, Ahmed Kanna underlines how flattened understandings of Arab culture are utilized for producing urban forms in the United Arab Emirates, see Kanna, Ahmed. 2011. *Dubai, the city as corporation*. Minneapolis: University of Minnesota Press, p. 93

[27] In the recent years, scholars in the social sciences and humanities have become interested in the promissory nature of capitalism, wherein forward looking statements give life to commercial futures, without necessitating material counterparts. For instance, Stefan Helmreich, researching how the ocean becomes marketable, suggests, "In promissory capitalism, after all, money need not be made off marine microbes but can sometimes just as well or better be made off promises about the sunken treasure that will be extracted from them in a possible, artificially selected, blue-ocean future." Likewise, in *Promising Genomics*, Fortun outlines "sequences of speculative activity as they operated across a range of global genomic territories," and studies the "forward-looking statements" that are abundant within his field site. Investigating speculations and promises that are associated with genomic research within Indian techno-science, Sunder Rajan states, "to generate value in the present to make a certain kind of future possible, a vision of that future has to be sold, even if it is a vision that will never be realized. The temporal order of production is inverted away from the present building toward the future instead towards the future always being called into account for the present." In this way, the imaginaries of a future potential constitute the reasons why and how any enterprise may be reliable or successful. Accordingly, he adds, "hype constitutes the grounds on which reality unfolds." All in all, Sunder Rajan concludes, for the "biotechnology corporation to exist and survive it is credibility, rather than truth, with which it is essential to start." But how exactly does a techno-scientific venture produce this credibility? Helmreich, Stefan. 2009. *Alien ocean: anthropological voyages in microbial seas*. Berkeley: University of California Press, Fortun, Michael. 2008. *Promising genomics: Iceland and deCODE Genetics in a world of speculation*. Berkeley: University of California Press, and Rajan, Kaushik Sunder. 2005. "Subjects of Speculation: Emergent Life Sciences and Market Logics in the United States and India". *American*

In their presentation, Daniel and the other architects working with Foster + Partners used references to the past, in this case the city of Shibam as one type of material evidence for why and how Masdar City could and would be realized, thereby producing solid historical grounding for their project. The frequently asked questions section of the Masdar website[28] also suggested, "Shibam in Yemen, Aleppo in Syria and Marrakesh in Morocco are just a few of the cities from the region that inspired the city's master plan, as well as traditional districts within Abu Dhabi, Dubai and other cities in the UAE and Gulf region." By clearly depicting its sources of inspiration, the designers of Masdar City formulated a credible trajectory for the emergent eco-city, positioning it as a natural conclusion to urban developments in different parts of the Arab world. In the meantime, by relying on and advancing this trajectory, Abu Dhabi acquired a critical centrality within the Arab world, constituting a new crossroads.

However, amongst the bundle of forward-looking statements associated with Masdar City, wherein the eco-city became a project of high technological caliber, the old city of Shibam seemingly lost its qualities as the material artifact that it had to be, and became part of the imaginary world of Masdar City. Did Shibam really exist? No one in the audience, including the architects, seemed to have experienced Shibam firsthand. Its now-fictional qualities, represented by a bird's eye view photograph in

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*Anthropologist.* 107 (1): 19-30.

[28] http://www.masdarcity.ae/en/110/frequently-asked-questions/ Last accessed March 2, 2012

the Foster + Partners slideshow, complemented those of Masdar. Here, Shibam stood in for a mythical Arab past, relegated to unattainable history and unapproachable geography. And Masdar, the materialization of a displaced longing for this past, epitomized the expectations for a mythical Arab future, currently under construction in Abu Dhabi.

Figure 3 The City of Shibam

The imaginary world of Masdar had been created step by step in meeting rooms, publicized through marketing and communications campaigns, and finally been materialized with the opening of the Masdar Institute campus. "When we first started the project," a marketing executive told me, "people thought that these were the quirky ambitions of an oil-led state, people thought that we are not serious."

However, now that the Masdar Institute campus stood erect, it could be used as a showcase through which other Masdar projects within Masdar Power, Masdar Carbon or Masdar Capital would be marketed. It also proved that Abu Dhabi was committed to its marketing and promotions campaigns. Thus Masdar City was promoted as the "Global Center of Future Energy," defined within corporate brochures[29] as "an emerging technology hub that positions companies located here at the heart of the global industry." Continuing, the corporate brochures suggested, "A place where businesses can thrive and innovation can flourish, Masdar City is a modern Arabian city that, like its forerunners, is in tune with its surroundings."

**Another Space and Another Time**

The official opening of the Masdar Institute campus, for now a metonymical representation of Masdar City, was scheduled for November 23rd 2010. A day before the inauguration, all Masdar Institute students received an email attachment with instructions on where they would be stationed throughout the ceremony, and what they would say upon meeting the high profile visitors to the building, such as Sheikh Mohammed, Crown Prince of Abu Dhabi. The document specified: "You need to identify yourselves and greet the guests by saying: Thank you for coming to Masdar Institute Inauguration, we are delighted to have you here, we will show you to the

[29] See one example here: http://masdarcity.ae/digitalbrochure/en/TheGlobalCentreofFutureEnergy/ Last accessed January 9, 2012

PRT cars." While six students were requested to welcome visitors at the PRT station, fourteen students were asked to be present at the Knowledge Center, "reading, working on laptops, checking books at 1st floor of the library," so as to allow the visitors to experience the building in operation. The remaining hundred or so students would be stationed at different locations on campus at different times. The students were also provided with a fact sheet, answering questions such as "What makes Masdar City special?" which would serve as reference points for their potential conversations with guests. They would re-deploy the marketing and promotions campaigns, this time through informal conversations. What they put on stage would serve as a natural representation of the future of Masdar Institute, with busy students absorbed in their work, "reading, working on laptops, checking books at the 1st floor of the library." When presenting the Institute, it somehow made more sense to introduce that abstract future, rather than showcase the current state of indeterminacy the fledgling institution was trying to overcome. In this performance, the students did not only pretend to exist in the future, but also demonstrated that there is no present, only a perpetual future where Masdar City was situated.

It was not only the staged performance by the students that enacted an idealized future, and seemingly proved the vacuity of the present. On the same day, when Norman Foster, the founder of Foster + Partners, delivered his lecture on sustainability, he suggested,

Many have dreamed of a utopian project that would be solar powered.

> Today's official opening of the initial stage of the Masdar Institute campus at Masdar City is a first realization of that quest. Its student community is already active, living and working in their quarters. This community, independent of any power grid, develops a surplus of 60 percent of its own energy needs, processes its wastewater on-site, which is recycled and pioneers many energy saving concepts. It is a bold experiment, which will change and evolve over time – already it houses twelve separate research projects with potential worldwide applications.

He continued by giving specific examples of the technologies utilized within Masdar. "There is a breeze that gives one a chill when standing below the wind-tower inside the Masdar campus," he said for instance, referring to a technological artifact that had long been under construction. A few days later, as we discussed the lecture, a post-doctoral researcher from the Institute laughingly said, "Has Norman Foster even been here and seen that the wind tower does not work, or did they make the wind tower operational for the moment that he was standing here?" And could Norman Foster imagine that his words would circulate around the wind tower in the form of everyday

Figure 4 Wind Tower at Masdar Institute Courtyard

ridicule? The architect's comments were rooted in an idealized version of the Masdar Institute campus, which would come to exist in an abstract future. He performed that future in his presentation, in the same way that the students performed future versions of themselves at the library.

According to Foster, the opening of Masdar Institute marked a moment in which science fiction or utopia, physically and socially constructed at Masdar, unfolded into material reality. It manifested that the forward-looking statements of Masdar were going to be solidified, in the same way that Masdar Institute started its operations. In this sense, the opening of Masdar Institute was more than the sum of its parts, proving how dedicated the professionals at Masdar were to the utopia of Masdar City. As one marketing executive said, it demonstrated that Abu Dhabi was "serious" in its endeavors.

The science fiction or utopia that Masdar Institute represented was further enacted and confirmed through campus visits. Having prepared an introductory statement for the visitors to the Masdar Institute building, marketing department representatives guided the guests, ranging from the Hollywood celebrities such as Adrian Brody and James Cameron and politicians, such as the United States Secretary of State Hilary Clinton and South Korean Prime Minister Kim Hwang-sik, to investors interested in building eco-hotel chains or organic grocery stores, and introduced the different research projects on site, in addition to showcasing the multiple technologies utilized for sustainability. "They believe in it, you can't question

the marketing statements," one Masdar employee told me, "then I hear people ridiculing the place on the bus, because they're not stupid. So we have to tell them the truth." He continued, "Here, when someone says it works, you have to agree, even though you're wrong." Around the time of our conversation, an article appeared in a German publication,[30] titled, "The Ruptured Dream of the Desert City Masdar" (*Der geplatzte Traum der Wüstenstadt Masdar*). The article described Masdar City as "a mirage that falls apart as you get closer to it," and argued that the technologies Masdar promoted did not actually work. Finally, the article put forth, Masdar "[is] a lesson for how delusions of grandeur, technical mistakes and above all poor planning can rob a fascinating idea of its credibility." The executives at Masdar City, above all, Sultan Al-Jaber, the Chief Executive Officer whom the article directly criticized, were enraged. One Masdar employee, who was on her way out of the company, told me that she very much agreed with the points that the article made. Did the repeated performance of an idealized future then compromise the credibility that an initiative like Masdar City so direly needed?

The frequent visits to the campus by famous personalities were also utilized as publicity campaigns, in national and international media outlets. When Hollywood celebrity Clive Owen toured the Masdar Institute building, for instance, his comments were framed under the title "Masdar looks like a city from the future: Owen" in the

[30] http://www.wiwo.de/technologie/modellmetropole-der-geplatzte-traum-der-wuestenstadt-masdar/5258478.html Last accessed January 22, 2012

national English-language newspaper *Khaleej Times*.[31] Owen, himself a leading actor in renowned science fiction films such as *Children of Men*, suggested that a science fiction film be shot at Masdar Institute.

In these understandings of futurity, the distinctions between "utopia" and "science fiction" disappeared, and the various terminologies became unified in their otherness, in their discontinuity from the lived experience of the everyday.[32] By equating utopia and science fiction, such conceptions of futurity also eliminated the possibility of what Raymond Williams refers to as a "humanist utopia," exemplified by Thomas More's *Utopia*, and restricted the dreams of the future to a technical "highly specialized, unequal but affluent and efficient social order," epitomized by Francis Bacon's *Atlantis*. As such, through its interchangeability with science fiction, utopia became confined to a techno-utopia. It was framed as a most viable way in which the present social, political and economic conditions could be sustained, even when Abu Dhabi runs out of abundant fossil fuel resources. In this way, rather than comprising a critique of the contemporary social, political and economic problems, Masdar City acted as a flagship, which promised to enable the present relations of production in an emergent future. Accordingly, the utopia or science fiction of Masdar City was perpetually arriving, hopefully before the inevitable crash of the Emirate's oil-export economy.

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[31] http://www.khaleejtimes.com/DisplayArticle.asp?xfile=data/theuae/2010/October/theuae_October373.xml&section=theuae&col= Last accessed April 11, 2012

[32] see Williams, Raymond. 1978. "Utopia and Science Fiction". *Science Fiction Studies*. 5 (3): 203-214.

**Man with a Brush**

"Masdar City is often perceived to be a perfect location for harnessing solar energy," Mahmood, an engineer with Masdar told me when I asked him about the implementation of renewable energy power stations, "but this perception is not completely accurate." He stated that high levels of dust and humidity associated with the Arabian Gulf not only blocked direct solar rays, but also resulted in thick coatings on solar panels thereby diminishing their effective functioning. "Although we can't fix the first problem that easily, we have found a solution for the second problem," he continued, "We call it 'man with a brush.'"

While there was extensive research towards the production of a solution for removing dust and humidity, and eventually mud, from solar panels in the UAE, no technical apparatus had proved as effective as the 'man with a brush.' There were ongoing experiments at a small solar power station on the Masdar City construction site as well as many other testing sites around the world, but Mahmood explained, none of them had been put into large-scale use. In this framework, the immigrant labor force became a most effective and essential resource for the emergence and functioning of sustainable renewable energy and clean technology infrastructures in the UAE.

However, when I asked Mohammed, a Bangladeshi man who worked in the kitchen, serving the Masdar Institute president's guests and earning 600 Dirham per

month (roughly US$160) in exchange for roughly 200 hours of work,[33] if he knew why so many individuals and groups find this building worthy of a visit, he shook his head no. A professor in the Institute had told him that solar panels provide energy to the campus. A few days later, an on-site architect criticized the conception of sustainability within these compounds: "How could sustainability truly be targeted when there is this little attention paid to human capital," he told me, pointing to the harsh working conditions for large populations of migrant workers within the United Arab Emirates. "Sustainability is also about claiming some sort of justice, and making sure that what we build leads this very young country towards a better direction. It is also about some kind of equality." In this way, he emphasized how the manual labor that enabled the construction and maintenance of the projects was also often glossed over, at times framed as a disposable tool, and finally excluded from the conception of sustainability on the construction site.

Accordingly, at Masdar, it was argued that oil would not be the main currency, and possible environmental problems would be subsided through meticulous research and technological discovery. The social and political injustices did not seem to matter that much.

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[33] On labor conditions in the UAE see Keane, David, and Nicholas McGeehan. 2008. "Enforcing Migrant Workers' Rights in the United Arab Emirates". *International Journal on Minority and Group Rights*. 15 (1): 81-115, and Khalaf, Sulayman, and Saad Alkobaisi. 1999. "Migrants' Strategies of Coping and Patterns of Accommodation in the Oil-Rich Gulf Societies: Evidence from the UAE". *British Journal of Middle Eastern Studies*. 26 (2): 271-298.

**Spaceship in the Desert**

Another much celebrated commentary regarding the futuristic aspects of the new Masdar Institute building came from a student's blog,[34] where she emphasized how being there felt like living in "a spaceship in the middle of the desert." The president of the Institute, and many other sources like the *Guardian* newspaper,[35] or the ecology blog Green Prophet,[36] cited Laura's blog when reporting on developments at Masdar Institute. The second-year student, who had accommodation within the new campus, underlined that she was writing that blog for a handful of friends and family members, while searching for reasons as to why and how it became so popular all of a sudden. Her post, like many other communications regarding the eco-city, was supported by the computer renderings that ornamented the walls of Masdar Institute, further articulating the promise that the futuristic city will one day be 'finished'. Masdar, which for some researchers in the institute was an instance of over-engineering, thereby situated renewable energy production within an imaginary of the future, somewhat excluding it from the possible configurations available to the present.

In Laura's understanding, the Masdar Institute campus became "an innovative technological model of a natural environment yet to come," which hinted at "a

[34] http://squidskin.blogspot.com/2010/09/i-live-in-spaceship-in-middle-of-desert.html Last accessed January 24, 2012
[35] http://www.guardian.co.uk/environment/2011/apr/26/masdar-city-desert-future Last accessed January 24, 2012
[36] http://www.greenprophet.com/2010/10/american-first-week-masdar/ Last accessed January 24, 2012

survival that is based on rational scientific management."[37] The experimental hub, of another time and another space, would technologically maintain the livelihoods of its residents. As Peder Anker[38] shows in his history of ecological architecture, this is by no means a new trend in design. Since the 1970s, Anker argues, "imagined and real environments in space [have come] to serve as models for ecological design of earthly landscapes and buildings," wherein adopting space technologies constitutes the singular means for being in harmony with the ecosystem. Anker[39] demonstrates that in the 1970s "life in space came to represent the peaceful, rational, and environmentally friendly alternative to the destructive, irrational, ecological crisis down on Earth." Accordingly, the spaceship would serve to create an "insular habitat for a small group of living beings facing a hostile outside world,"[40] providing "the joy of perfectly enclosing oneself, of having at hand the greatest possible number of objects, and having at one's disposal an absolutely finite space." [41] Similarly, Masdar City, here metonymically represented by Masdar Institute, was to showcase the potentials for an environmentally friendly alternative, setting a stark contrast to the oil-led economy of Abu Dhabi. As such, this center of renewable energy not only instigated the construction of a particular future-oriented temporality, but also pointed

[37] Höhler, Sabina. 2010. "The Environment as a Life Support System: the Case of Biosphere 2." *History and Technology* 26 (1): 39-58
[38] Anker, Peder. 2010. *From Bauhaus to Eco-house: A History of Ecological Design.* Baton Rouge: Louisiana State University Press.
[39] Ibid.
[40] Sloterdjik, Peter. 2008. *Kapitalist Dünyanın İç Evreninde* [Im Weltinnenraum des Kapitals]. Istanbul: Kırmızı Yayınları
[41] Barthes, Roland. 1972. *Mythologies.* New York: Farrar, Straus & Giroux, p. 65-68

to a particular spatiality with firm boundaries. This ecological design would assist Norman Foster, the founder and chairman of Foster + Partners, in producing a legacy for himself, one of the on-site architects told me. "Norman wants to be the Bucky Fuller of this century."

Buckminster Fuller was an influential inventor and engineer, who conceived of earth as a beautifully designed spaceship that only lacks a comprehensible operating manual, thereby putting together his book "Operating Manual for Spaceship Earth."[42] "We are all astronauts," Buckminster Fuller[43] asserted, "We have not been seeing our Spaceship Earth as an integrally-designed machine which to be persistently successful must be comprehended and serviced in total." Since "no instruction book came with it," Fuller considered humankind to be confronted with the challenge of self-instruction to successfully operate Spaceship Earth and "its complex life-supporting and regenerating systems." In this conception of earth,[44] human beings were allowed "the possibility of seeing the planet as an alien would see it," and thereby experiencing an "uncanny sense of being alien to one's own consciousness." Earth, in the meantime, became an operable technological object, fully accessible to humankind. Buckminster Fuller not only wrote about his various understandings of Earth, but also went ahead with multiple engineering projects illustrating his philosophy, such as the

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[42] Fuller, Buckminster. 2008 [1969]. *Operating Manual for Spaceship Earth.* Rotterdam: Lars Müller, also see Anker, Peder. 2010. *From Bauhaus to Eco-house: A History of Ecological Design.* Baton Rouge: Louisiana State University Press.
[43] Fuller, Buckminster. 2008 [1969]. *Operating Manual for Spaceship Earth.* Rotterdam: Lars Müller, p. 52-54
[44] Helmreich, Stefan. 2009. *Alien ocean: anthropological voyages in microbial seas*. Berkeley: University of California Press, p. 258

geodesic dome.

Norman Foster, then a young architect, had met Buckminster Fuller in 1971 to collaborate on the construction of Samuel Beckett Theatre in Oxford. The theatre, which marked the beginning of their twelve-year relationship, was a subterranean building intended to be used as classrooms and exhibitions space for St. Peter's College, and it benefited from the geodesic lightweight structures that Fuller was renowned for. Although it was never built, Foster claims that this building strongly impacted the later stages of his career, not only in terms of his relationship with Fuller, but also in more formal ways: "I remember that Bucky made the comparison with a submarine because the structure of the building had to be resistant to water, like a seaworthy vessel. The building had to stand up to the ground water and other natural underground forces. So it's no coincidence that my later underground projects also take the form of ships and submarines."[45] Although none of their collaborative projects were completed, in his Pritzker Prize biography, Foster is quoted to say, "The thing about Bucky was that he made you believe anything is possible." Foster adds, "The themes shelter, energy and environment best summarize Bucky's inheritance…For me Bucky was the very essence of a moral conscience, forever warning about the fragility of the planet and man's responsibility to protect

[45] Meijenfeldt, Ernst von, and Marit Geluk. 2003. *Below ground level: creating new spaces for contemporary architecture.* Basel: Birkhäuser-Publishers for Architecture, p. 130.

it."[46]

When I asked Brad, a Masdar executive originally trained in architecture, if he understood the Masdar City project to be subscribing to the Buckminster Fuller legacy, he reminded me, "When Bucky spoke, no one listened to what he had to say," and celebrated how his ideas were finally being applied today at Masdar City, at least to a certain extent. Later, during an email exchange, he further explained how he related to Buckminster Fuller's work:

> What he did was synergetics, meaning taking a holistic view of things, he was also structure oriented. He looked at nature for instance, at fractals, and then did biomimicry. Bucky just as we do, understood that the problem was with the system i.e. the industry. Bucky's visions and aspirations all orientated around creating a new system and solution instead of attempting to change the existing establishment. All the resistance he faced was from institutions or unions opposing radical change, hence many of his ideas were never realised, sadly until today, 50-60 years after invented or in some instances - not at all…

But Brad was also aware of the difference between Masdar and a Buckminster Fuller model city, and reiterated:

> One way that our cities today differ from Bucky's visions, is that a Bucky city would probably have been self-built by communities and perhaps would have been both mobile by nature, and completely off-grid/off-system in all its infrastructure and services. Something that is easier to write or imagine than accomplish in reality, due to various challenges and barriers that are political, social, economical, personal, cultural and regulatory.

[46] Zung, Thomas Tse Kwai. 2002. *Buckminster Fuller: anthology for a new millenium*. New York: St. Martin's Press, p. 2.

While the spaceship analogy, rendered significant by the readers of Laura's blog, in fact underlined the possibility of a city that is "mobile by nature, and completely off-grid/off-system in all its infrastructure and services," Brad did not perceive Masdar to be completely fulfilling these requirements. In addition to pointing to how Masdar is a master-planned city, surely not organic in its development or growth, Brad thought of Masdar as dependent on the grid for its infrastructure and services. In this understanding, could Masdar still constitute a ship or a submarine?

The legacy of the ship and the submarine continues to characterize some of Norman Foster's design work. After being pointed to as the architect who would build on the moon, in case the project was ever realized,[47] Foster also proposed that he understood practicing architecture in the Arabian Gulf to be similar to building on the moon.[48] News commentaries[49] rather fascinated with the idea of building an eco-friendly city in the desert also state, "The inhospitable terrain suggests that the only way to survive here is with the maximum of technological support, a bit like living on the moon." In his autobiography[50] the Emirati banker Easa Al-Gurg also demonstrates that Emirati rulers understood the desert as a moonscape by describing how Sheik Rashid of Dubai dismissed the moon landing as a hoax, and argued that

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47 Man on the moon: Norman Foster prepares for architecture's lift-off http://www.guardian.co.uk/artanddesign/2009/sep/22/moon-norman-foster-architecture Last accessed January 24, 2012

48 Norman Foster: Building an Oasis http://www.thenational.ae/arts-culture/norman-foster-building-an-oasis Last accessed January 24, 2012

49 Masdar: Abu Dhabi's carbon neutral city: http://news.bbc.co.uk/2/hi/middle_east/8586046.stm Last accessed January 24, 2012

50 Al-Gurg, Easa Saleh. 1998. *The wells of memory: an autobiography*. London: J. Murray.

the landscape looked like the empty terrain in Ras Al-Khaimah.[51] Maybe it was filmed there, Sheik Rashid said. Quite appropriately, a slideshow presented at Masdar City by the on-site architecture team showcased an image that juxtaposed astronaut Edwin Aldrin standing next to the Lunar Module with the gray lightweight cladding used to insulate the lab buildings in Masdar Institute. A few days later, the president of Masdar Institute spoke on Richard Quest's CNN documentary about Masdar City,[52] underlining that when the United States wanted to send a man to the moon, it produced NASA, and now, when the UAE is transforming its economy, it is building Masdar City.

**The Frontier**

But what did it mean that the construction of Masdar City could be compared to the moon landing or an exploratory trip to outer space? Looking back at the Apollo space program that the president of Masdar Institute touched upon in Richard Quest's CNN documentary, David Mindell[53] writes,

> None of the symbolic power of the spaceflight was lost on the visionaries who promoted [it]… Kennedy seized on the most powerful mythology in American history, the frontier narrative, and reopened it by aiming for the moon. Within this framing, the endeavor had all the elements of a classic frontier adventure: an unknown, but conquerable geography full of lurking dangers, even villainous antagonists—the

[51] Ras Al-Khaimah is one of the seven Emirates that constitute the UAE.
[52] Quest, Richard. CNN. World's Most Futuristic City. http://www.youtube.com/watch?v=IJjbqDq9_QE December 6, 2010
[53] Mindell, David A. 2008. *Digital Apollo: human and machine in spaceflight*. Cambridge, MA: MIT Press, p.12

> competing Soviets. Most important, the frontier narrative called upon heroic pioneers…Human presence made spaceflight into a story. For the American public, that story involved people who embodied American virtues, from humility and self-control to self-reliance and creativity…And for that story to be credible, the astronauts had to be in control. Frontiersmen could not be passengers.

In the same way that the moon had become a frontier for the American public, the Abu Dhabi desert transformed into a renewed resource frontier, from which a novel means of livelihood would emerge. Pioneering in clean technologies and renewable energies, the frontiersmen of Masdar City would be in charge, not only abiding by the principles enacted by the Abu Dhabi government, but rather taking initiative to produce a next generation of innovations. As Rosalind Williams[54] in discussing how real or imaginary subterranean spaces emerged as potential getaways from the environmental crisis, highlights, "Today, not the city but the spaceship has become the standard image of the megatechnic ideal of complete detachment from the organic habitat. This newer image, however, denies the claustrophobic realities of human life on earth. Although the spacecraft itself may model an all-encompassing technological environment, its mission-hurtling through endless space, going boldly where no one has gone before-suggests the vision of an endless frontier where new varieties of nature wait to be discovered." These frontiersmen would thereby substitute oil, the long harvested product of the desert, with renewable energies. Only through such re-discovery of the desert would Abu Dhabi ensure its post-oil survival.

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[54] Williams, Rosalind. 2008 [1990]. *Notes on the Underground: An Essay on Technology, Society, and the Imagination*. Cambridge: MIT Press, p.7

In this expanding geography, the students would take charge as astronauts, managing the successful institution of an eco-friendly frontier within an oil-led economy. Perhaps this could be the reason why Laura's blog featured a comment from a former Masdar employee, celebrating an optimistic becoming: "Brave people living on the island, it will get better and better…".

But Höhler[55] reminds her readers that "Appropriating space by compiling, registering, and neatly arranging the elements within it is a strategy not limited to the modern era of scientific collecting, archiving, and interpreting of the world. The procedure recalls the primal ship representing the inventory of the world, the biblical ark." As such, like the spaceship, the biblical ark speaks to a future that emerges from within an enclosed space. The frontier rationale led the producers of Masdar City to understand the present as a vacated moment, and concentrate their efforts on constructing a future, which would emerge from this enclosed space, or this ark, within the Abu Dhabi desert. Accordingly, it could be argued, it was not only the space of the Abu Dhabi desert that awaited a re-discovery, but also its temporality.

This is what Alan Frost, the director of Masdar City, evoked during a presentation at the World Future Energy Summit in January 2011, suggesting: [56] "When we started Masdar City, we thought it was an island, we thought that basically we were doing all these things people had not done before, we could do it all on our

[55] Höhler, Sabina. 2010. "The Environment as a Life Support System: the Case of Biosphere 2." *History and Technology* 26 (1): 39-58.
[56] Presentation at World Future Energy Summit, Abu Dhabi, UAE, January 18th 2011.

own, and then we come back and tell everyone about it. But you know what, that's not very healthy… So, the lesson is that you cannot be an island." The master-planned city, which would be fully constructed and thereafter sold by Masdar Initiative, reformulated its business plan after the economic crisis of 2008, and invited renewable energy and clean technology companies to start building their headquarters within its boundaries. This way, the city's growth would not depend completely on the funds made available by Abu Dhabi authorities. "There is no point in doing something, which you can only do at Masdar. It has to be sustainable and it has to work for Abu Dhabi... Everything at Masdar City has to be translatable and repeatable around the world," Frost continued, inviting third parties to participate in this economic diversification project. As such, Masdar City sought to constitute a showcase for multiple energy technologies that may later be purchased and used around the world. On top of this, Masdar City as a whole would be conceived as an exportable commodity, leading to the production of its replicas around the globe. In this context, the eco-friendly building of Masdar Institute contained not only an environment within a spaceship-like arrangement, but also the possibility to further spread that environment in an undefined future. In some ways, Masdar carried the promise to create that future for everyone else.

Nevertheless, Masdar Institute students, the frontiersmen of Abu Dhabi's emergent eco-city experiment, remained unsure about the translatability of Masdar City into other settings. As such, on February 1st 2011, they gathered in the Masdar

Institute auditorium to debate whether "Masdar City is an elite enclave of sustainability, unsuitable for the rest of the world" or not. The team that defended the statement argued how Masdar is "too unique" to be applied elsewhere. First, Masdar was very expensive. Which other country, other than the oil-rich UAE, would be able to devote 22 billion dollars for an eco-city? Second, they recalled how this project had been put together to bolster the economic vision of Abu Dhabi, thereby contributing to its economic diversification, and perhaps would not be financially feasible or meaningful for other countries with different economic strategies. Third, they added, authoritarian rule was working in favor of Masdar City by providing prolonged commitment and stability. "Well, other than that," the pro-team reiterated, "the concept of a green city has existed for a long time." In this understanding, Masdar City stopped constituting a vision that would unfold into the future. Rather it remained an island, exactly what Alan Frost had argued against, contingent on a specific set of circumstances, available within the UAE. Abu Dhabi's oil capital, its future economic vision, and its authoritarian rule were thus perceived as the preconditions for the emergence of the Masdar City concept. How could these conditions be satisfied elsewhere?

In response, the con-team proposed that Masdar City should rather be understood and framed as a prototype: Abu Dhabi would shoulder the burdens of building the eco-city, and others would benefit. "Every new idea is expensive," one of the students underlined, "think about the car, first rich people had it and now it has

spread around the world." As such, Masdar City could become less expensive in an undefined future, and thereby would be exported to other countries, in the same way that the car and its infrastructures had been exported. In the meantime, the experiments taking place at Masdar would be learning experiences for the rest of the world, eventually adapted to other regions in bits and pieces.

At the end of the debate, one student approached me to express his dissatisfaction at how none of the students in the debate teams had actually defined what Masdar was, or what exactly they expected it to spread around the world: "No one talked about the personal rapid transit units, or the motion sensors," he specified, pointing to the technologies that seemingly defined Masdar for him. What did Masdar inhere, and what would it pass on to the rest of the world? What kind of future did the eco-city promise, eventually?

**Enabling the Future**

At the World Future Energy Summit 2011, where Alan Frost gave his talk about Masdar City, many other renewable energy and clean technology companies highlighted their relationship to the future, with slogans such as: "Tomorrow is Today," "Enabling the Future," or "For a Better Tomorrow and Greener Earth, ARDECO is at the Forefront of Turning Today's Resources into Tomorrow's Clean Energy." A writer who blogged about the World Future Energy Summit suggested, "Matter of fact, the most significant word in the name of this global clean energy conference is *future," and* wondered what this meant about the United Arab Emirates'

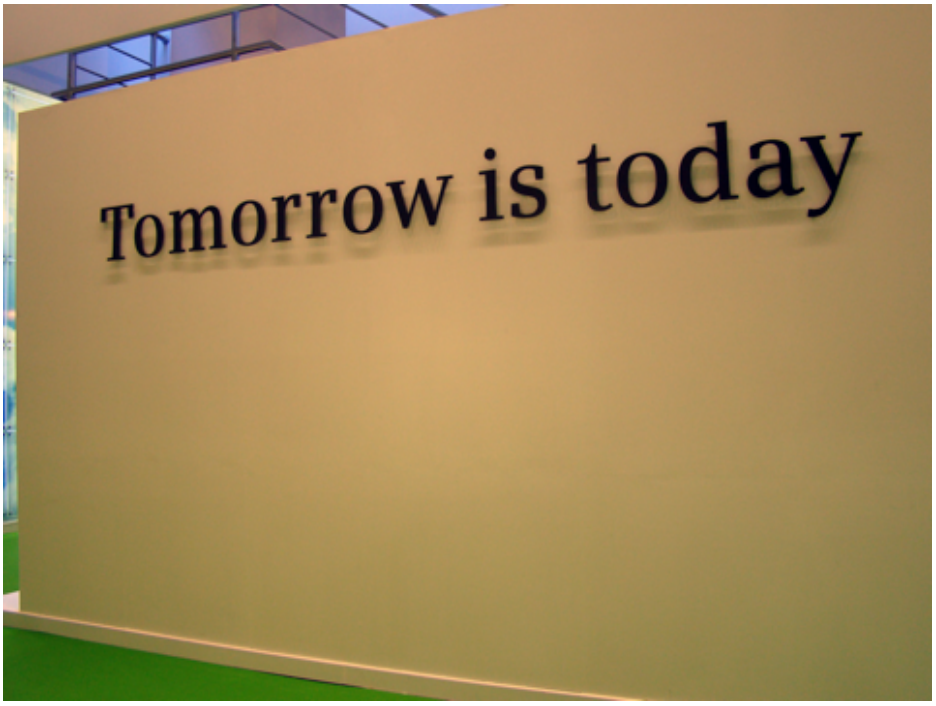


Figure 5 Siemens Pavilion at World Future Energy Summit 2011

relationship to clean technology and renewable energy.[57] "Today, Abu Dhabi is awash in oil money and emitting carbon at a furious pace," the blogger said, and provided details on the social and economic infrastructure of the United Arab Emirates, with ski sloped malls and golf courses that are cooled for tourists to seven-star hotels, concluding his entry with this statement: "The future can't come soon enough."

And yet perhaps it was not fair to direct such criticism uniquely at the United Arab Emirates, and their engagements with clean technology and renewable energy infrastructures, especially because the major players in the industry seemed to be betting on the future as well. For instance, when I asked a Siemens representative what they meant with their slogan "Tomorrow is Today," he argued that as Siemens they had access to all the technological tools that would be

Figure 6 General Electric Pavilion at World Future Energy Summit 2011

[57] http://www.marcgunther.com/2011/01/17/abu-dhabi-oil-today-green-tomorrow/ Last accessed January 21, 2012

used "Tomorrow," but unfortunately mindsets and infrastructures were not ready to embrace what they had to offer. "We test our products at Masdar City," one Siemens representative suggested, "which is also in the future." Siemens representatives also explained that the company is involved in a project called the "Office of the Future," where they will work on optimizing their offices. They told me that one of these offices would be situated within Masdar City. On the other hand, in their marketing slogans, General Electric suggested that the company would be "Enabling the Future," with smart appliances, in addition to other technological gadgets that would be part of the energy mix. When I asked him if he could elaborate on these statements, a GE representative stated, "In the future everything will be smart and regulated, just as they are at Masdar City." Less prominent corporate figures, such as Arab Development Establishment (ARDECO), with business operations in a variety of areas like the oil and gas and the power and water sectors, promoted that they would also be part of the "future" energy mix.

Why did the present not act as a relevant category for actors within the renewable energy and clean technology industry, including Masdar City? Asif Ali Zardari, the president of Pakistan, who spoke during the World Future Energy Summit 2011, underlined that we must not mourn for the excesses of the last century, but rather work on developing a vision for the future. As such, while the 20th century became framed as a time of decadent pleasures, the future, explored under the wings of the governments and corporate entities present within the World Future Energy

Summit, would prove to be marked by responsible consumption of energy. Accordingly, renewable energy and clean technologies, such as those promoted at the World Future Energy Summit, carried the seemingly messianic promise of liberation from such guilt-ridden consciousness, created through the excesses of the 20th century. In this framework, the present, a vacuous category, was spared for promises, or for the performances of an idealized abstract future.

**Resource Management**

"There are projections like in seventy years a bottle of water will cost $500," Mazen told me, during a long conversation in his office. "We shouldn't let that happen. So in the long run, we need something that alters capitalism, which sort of reformulates consumerism. But of course, these are only long-term goals, and this is not how or why we started Masdar," he concluded. Capitalism needed to be changed, but it would only happen at a later time, and Masdar, or Mazen for that matter, could not take responsibility for this challenge. The reformulation of consumerism that Mazen hoped for also had to be deferred to an undefined future – this time, a future rarely discussed in marketing and communications campaigns for renewable energy and clean technology companies. For now, the emergent technologies, with transformative potentials, would be embedded within the existing market infrastructure.

According to Mazen, the Masdar City project was a renewed attempt at resource management, not necessarily to be framed as environmentalism. "That's why," he told me, "you should not be surprised to see hundreds of SUVs parked outside Masdar offices." The performance of the future, enacted inside Masdar City, through personal rapid transit units or electric cars, ended at the gates. And yet, by abandoning the claims to environmentalism, the discrepancies between the inside and the outside, or the present and the future, were expected to disappear.

In its non-environmentalism, Masdar would represent a continuation of the present social, political and economic relations, both spatially and temporally. In this sense, it sought to constitute a version of today, for a space and time in which fossil fuel resources would be replaced by renewable energy and clean technology. Accordingly, in this space and time, monetary currencies would be superseded with energy currencies and cars would be substituted with personal rapid transit pods. As a non-environmental project, Masdar would merely provide these technical adjustments.

In its everyday, however, Masdar City, as an ever-evolving entity, remained a showcase for a bounded experiment with renewable energy and clean technology, ascribed to an imaginary of the future.

In the next chapter, I will contextualize the production of this showcase within Abu Dhabi's transformation into a knowledge-based economy, while further elaborating on the establishment of Masdar Institute.

## CHAPTER TWO:

## THE ESTABLISHMENT OF ABU DHABI'S MASDAR INSTITUTE

### Agreement

In February 2012, the UAE Ministry of Education organized a forum titled "Bridging the Knowledge Economy" at the Zayed University campus in Abu Dhabi.[58] In the forum, Dr. Lamya Fawwaz, Executive Director of Public Affairs at Masdar Institute, reportedly said: "This forum is certainly timely to further spur investment in R&D in light of the concerted efforts by the UAE leadership, to move towards a knowledge-based economy. We believe the event will provide us not only essential knowledge but also a great opportunity to share ideas and experiences on major topics crucial to R&D projects and opportunities." Presidents of universities in the UAE, in addition to representatives from the Ministry of Education, attended the meeting to formulate strategies regarding how the education system could cater to the production of a knowledge-based economy. What were the steps that they needed to take?

The attempt to move towards a knowledge-based economy had been the driving force in the signing of an agreement with Massachusetts Institute of Technology's Technology and Development Program (TDP) in December 2006,[59] regarding the building of a new science and technology institute at the center of

[58] http://www.middleeastevents.com/site/pres_dtls.asp?pid=15009 Last accessed February 22, 2012

[59] The agreement between Masdar Institute and TDP was renewed in December 2011, and is expected to last until December 2016.

Masdar City. According to this cooperative agreement, TDP would assist "in the establishment of a graduate institute and…collaborate on research projects of interest to both parties," in this case, Massachusetts Institute of Technology (MIT) and Masdar Institute. Faculty members were to be recruited on four-year contracts, and expected to spend the first of these four years at MIT, building research and teaching connections.[60] These connections would provide the new faculty members with a track for the remaining years of their careers at Masdar Institute.

Classes would begin in Abu Dhabi on August 23, 2009, comprising "five master of science curricula, [which] have been developed for offer in Abu Dhabi fall 2009, namely, mechanical engineering, materials science and engineering, engineering systems and management, information technology, and water/environment. By August 2010, two additional master of science programs [would] be put in place."[61] In August 2011, the Institute would start admitting PhD students as well.[62]

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[60] Research projects that could not be carried out in the United States due to strict IRB protocols, such as smart grid testing, could be put in place in the UAE. As such, while the MIT faculty would not receive intellectual property rights for projects taking place in Abu Dhabi, they would be learning from their research partners. In this sense, the research agreements between MIT and Masdar Institute were argued to be reciprocal, granting benefits to both parties. However, not everyone agreed with this argument about reciprocity. One faculty member at Masdar Institute insisted for instance that their faculty partners at MIT were most of the time not invested in these collaborative projects. Referring to the sums of money that the MIT faculty received for providing syllabi and other basic forms of guidance, she emphasized how they enjoyed extensive financial privileges through these contracts.

[61] MIT Reports to the President 2007–2008: http://web.mit.edu/annualreports/pres08/2008.08.20.pdf Last accessed April 6, 2012

[62] In its first year of operation, Masdar Institute had 92 students from 22 countries, who were provided with full tuition scholarship, monthly stipend, travel reimbursement, personal laptop, textbooks, and accommodation. In my conversations with them, many of these students suggested that what drove them to Abu Dhabi was the attractive funding package, the MIT involvement in the project, laboratory facilities, and the particular emphasis on renewable energy and clean technology.

When I met Fred in March 2009 for the first time, he had been the head of the TDP for thirty-seven years. In these thirty-seven years, he had seen the organization transform from an infrastructure-focused development program to an education focused one. After assisting with transportation projects in Latin America and East Africa, the TDP had been involved with educational restructuring in the Middle East, specifically working with Cairo University, the American University of Beirut, and Kuwait University. Next, they had embarked on two university projects that were similar to Masdar, setting up brand new science and technology institutes in Thailand and Malaysia. While TDP had been considered successful in their transportation and educational restructuring projects, its brand new universities in Southeast Asia had not progressed as predicted, due to malfunctioning relationships between the different parties involved in the projects.

With Masdar Institute, though, the conditions seemed slightly different. Abu Dhabi's economic vision for the upcoming decades[63] depended on the development of science and technology infrastructures within the Emirate, as they attempted to restructure their oil-export based economy into a knowledge-based economy. Here, human capital was expected to be a means of increasing productivity, and furthering innovation within the country. As such, well-educated individuals, with a mass of

[63] See Abu Dhabi Economic Vision 2030: http://www.masdarcity.ae/userfiles/files/economic-vision-2030-executive-summary-mandate2.pdf Last accessed February 20, 2012

skills and knowledge on science and technology, would seemingly replace Abu Dhabi's oil resources.

In this framework, the TDP staff understood their project to be the backbone of Abu Dhabi's economic restructuring and hoped that problems such as a lack of commitment on the side of their local partner would not negatively impact their future prospects. Their agreement was expected to last until Masdar Institute could become a credible institution, able to stand on its own two feet, but there was no clear timeline or instructions as to when or how this would happen. They would renew their contracts every five years, and see what happens at the end. When administrative problems started to emerge in Masdar Institute in August 2010, Fred agreed to move to Abu Dhabi and accept a position as the president of the fledgling research center, making TDP's work truly hands on.

By investing in a research center like Masdar Institute, Abu Dhabi prepared for an oil-less economic infrastructure and indicated that it embraced new categories in defining its expectations of the future. In some ways, the production of such infrastructures was a wake up call to the citizens of the UAE to begin to participate in a new economy, and become more aware of the upcoming depletion of abundant oil supplies.[64] In the case of Abu Dhabi, such urgency required the immediate production of infrastructures that would facilitate the proliferation of individuals that

[64] As Nigel Thrift argues, this move may be perceived as an attempt "to engineer new kinds of…subject positions that can cope with the disciplines of permanent emergency." Thrift, Nigel. 2000. "Performing Cultures in the New Economy". *Annals of the Association of American Geographers*. 90 (4): 674-692.

create, circulate and comply with a certain set of ideals based on innovation. Accordingly, in Abu Dhabi, knowledge began to constitute a resource in its own right,[65] with the underlying assumption that innovative intellectual products and services can be exported for a high value return. Unlike other oil-producing countries, such as Oman,[66] where progress became tainted by the inevitable disappearance of resources, in coping with the possible depletion of oil, Abu Dhabi physically and socially constructed knowledge on renewable energy and clean technology as an alternative resource, thereby attempting to safeguard the future.

In this chapter, I seek to show how knowledge in Abu Dhabi became instrumental to practices of economic development, wherein the upcoming science and technology infrastructure would act as a hotbed from which new exportable ideas would emerge. Analyzing the institution of this new vision, I suggest that "beautiful buildings" and "research contracts" were critical means through which Abu Dhabi's oil-based relationships transformed into knowledge-based relationships. Yet perhaps, this was not an entirely new strategy. By referring to TDP's history, I understand that such beautiful buildings and research contracts had been relatively significant to the production of research institutions in countries such as Egypt, Lebanon and Kuwait as well. Lastly, I argue, such relationships would facilitate the production of knowledge infrastructures in Abu Dhabi, but then again, the emergent knowledge

[65] Callon, Michel. 2007. "An Essay on the Growing Contribution of Economic Markets to the Proliferation of the Social". *Theory, Culture & Society*. 24 (7-8): 139-163.
[66] Limbert, Mandana E. 2010. *In the time of oil: piety, memory, and social life in an Omani town*. Stanford, Calif: Stanford University Press.

infrastructures were expected to initiate new relationships as well, enabling Abu Dhabi to grow as an economic, cultural and scientific center.[67]

**Knowledge-Based Economy**

The "Bridging the Knowledge Economy" event held in February 2012 was a follow-up to an earlier meeting, which had been held at the World Future Energy Summit of 2011, wherein presidents of universities in the UAE and administrators from the Ministry of Education had discussed similar strategies. A spokesperson of Abu Dhabi Education Council had explicitly stated that they wanted to host intellectuals from around the world, produce a cultural infrastructure, as exemplified by Abu Dhabi's efforts to build a Louvre Museum, a Guggenheim Museum, a Sorbonne University and New York University's Abu Dhabi campus on Saadiyat Island, organize a network of events, conferences and libraries, eventually producing the "right culture" for the emergence of a community of intellect. This had to start at the high-school level, he had emphasized. They would like to have students who think critically, and who could wrestle with the difficulties of a competitive labor market.

[67] I would also add that a very similar transformation is taking place in other Gulf countries, especially in Qatar, where the government invests in arts and education, with the expectation of establishing a knowledge-based economy. It may be argued that these transformations, happening in oil and gas rich countries, are fueled by the anxiety of being fully dependent on revenues from such finite resources.

As Bob Jessop[68] argues, "On the one hand, knowledge is an extremely heterogeneous and deeply contested category both ontologically and epistemologically and, as social scientists of various stripes have shown, knowledges (or truth regimes) are intimately linked to the material and discursive (or, better, material–discursive) conditions of knowledge production and management." In this sense, the material knowledge infrastructure that the Abu Dhabi Education Council emphasized would be significant in shaping the type of knowledge that would be produced within Abu Dhabi. "And, on the other hand," Jessop continues, "knowledge is a collectively generated resource and, even where specific forms and types of intellectual property are produced in capitalist conditions for profit, this depends on a far wider intellectual commons." While accepting that knowledge is produced through the commons, with attention to the "right culture" wherein new ideas would be born, the spokesperson, like his colleagues, highlighted human capital. The knowledge that would be produced collectively would stick onto individuals, who would later make proper economic use of what they had learned.

"For developing human capital," the chancellor of the American University of Sharjah, stressed, "we need to develop open, collegial dialogue among the universities, where the university will be responsive to government and private sector priorities." On the other hand, the provost of UAE University argued that the emergence of

[68] Jessop, Bob. 2005. "Cultural political economy, the knowledge-based economy and the state" in *The technological economy*, edited by Andrew Barry and Don Slater, p. 142-165. London: Routledge, p. 156

doctoral programs within the country would contribute to the production of a research community, and suggested that the UAE universities had to act fast and address the needs of commercial and public sectors. Furthermore, the provost of Zayed University noted how universities had to play a larger role in economic and social development, research and training.

All in all, in these forums, knowledge and universities were perceived as objects with practical end-goals, with a greater emphasis on the significance of human capital. In this framework, human capital, an aggregate of knowledge, abilities and skills acquired throughout an individual's lifetime, was perceived as a way to increase productivity, as well as a source of long-term innovation within the country. In the long run, well-educated individuals would serve to substitute Abu Dhabi's physical capital of oil, eventually enabling the country to transform from a resource-based economy to a knowledge-based model.

The investment in human capital also constituted an attempt to include more Emiratis within the work force. As Davidson[69] notes, since the foundation of the UAE in 1971, Emiratis have been consistently provided with the material benefits of the oil-extraction economy, thereby lacking motivation to participate in a competitive labor market. While there are no reliable statistics on the issue, Davidson suggests that the nationals make up about nine percent of the workforce. In resolving this

[69] Davidson, Christopher M. 2009. *Abu Dhabi: Oil and Beyond*. New York: Columbia University Press, p. 149-152

problem, he argues, "the only long-term solution is improved education at all levels," through which Emirati citizens will acquire the necessary skills to compete with the large number of expatriates living in the UAE. Studying the history of the education sector, Davidson finds that the one major problem leading to a lack of education amongst Emiratis has, rather shockingly, been a "lack of funding." He writes, "Although the federal budget allocation for education now exceeds $2 billion, this is only a third of the allocation for military expenditure and, in relative terms, is about a quarter of the educational expenditure of some other Arab states." Accordingly, Davidson understands the new emphasis put on education through the founding of NYU-Abu Dhabi, Masdar Institute or Sorbonne to be a very positive one, both towards training more qualified Emirati youths, and in making the education sector more high profile.

In a similar vein, the representatives from institutions of higher education pointed to how the cultivation of a citizenry that would live and invest in the country was essential in the production of a knowledge-based economy in the UAE. With this thought in mind, Masdar had started a foundation course exclusively for Emirati students, where thirty applicants who were not qualified to start master's degrees were provided with the opportunity to take preparatory classes, and if successful, to continue with graduate programs at the Institute. In some senses, the youth of Abu Dhabi were expected to start becoming active participants in the formation of wealth, rather than solely relying on the benefits of oil production. As the representatives of

higher education institutions hinted at, this would be a major challenge for the years ahead.

All in all, these meetings strived towards "making knowledge into a direct agent of the technical-artistic transformation of life."[70] In this way, knowledge in the technical sphere, symbolized by Masdar City and Masdar Institute, and in the artistic sphere, represented by museums, art fairs, and biennales, would be utilized to generate a push, reconstituting Abu Dhabi as a knowledge-based economy. In this economic vision, categories of the technical and the artistic were to be merged, and serve both as products and generators of innovation. In this context, the definition of knowledge transformed from "being thought of as a passive store," to "a set of continuously operating machines for activating competences, risk taking and readiness to innovate." Not only did knowledge serve as a means of "changing perception," but also performed "as a means of boosting difference and inserting that difference into the cycles of production and reproduction of capitalism." Through these knowledge infrastructures, Abu Dhabi would re-fashion itself for an oil-less future.

The reproduction of capitalism that was expected within the UAE was clearly outlined in government documents as well. "By 2030, Abu Dhabi's population is expected to more than triple," a document outlining the economic vision of Abu

[70] Thrift, Nigel. 2006. "Re-inventing invention: new tendencies in capitalist commodification". *Economy and Society*. 35 (2): 279-306, p. 281

Dhabi predicted.[71] As such, the Emirate sought to boost the non-oil share of the economy to more than 60% of GDP, from just over 40% today. Like other oil-producing countries, such as Saudi Arabia, the UAE strived to transform from being a resource-based economy to a knowledge-based one. Rather than going further in the direction of "primitive accumulation," and being dependent on oil extraction, the UAE sought to "to try to squeeze every last drop of value out of the system by increasing the rate of innovation and invention through the acceleration of connective mutation."[72] They would build upon the ideas presented by prospective youths.

Fred, who had accepted an appointment as the president of Masdar Institute in August 2010, concluded the February 2012 meeting by suggesting,

> Education at all levels is necessary for development, not only for the knowledge, but people have to get accustomed to what type of innovation they are looking at. The corroborative nature of this activity is vital, as all the industry, government and academic need to come together. Then comes the technology rewards system – the IP [Intellectual Property] rights in terms of the regulatory system that has to contribute to encourage venture capitalists and development of ideas and applications. Lastly, the relevance to need, especially the work we do has to reflect on the needs of the economy. There must be a balance between the research and applications to reflect the needs of the society.

Between the lines, he seemed to be calling out to the Abu Dhabi government, and warning them that the knowledge-based economy would not materialize very quickly.

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[71] http://www.forbescustom.com/abudhabi/index.html Last accessed April 10, 2012
[72] ibid, p. 281

**A Catalyst**

On their official website,[73] the TDP staff explained their work, initially suggesting that "The process is complex, and dependent on the individual circumstances of each country, each initiative has to face." Their statement continued:

> At the invitation of academic institutions, working with local government, TDP supports the establishment of graduate-level research and educational facilities. From the start, TDP establishes relationships of cooperation with academic institutions, local government, and industry and works to ensure government supported research facilities are privately managed and independent of governmental administration. We share our knowledge, providing guidance and assistance in the scholarly assessment of curriculum and top tier faculty. TDP sets a level of quality control in the establishment of these intellectual centers that ensures the development stream essential for the critical thinking necessary for these endeavors. Our organization is lean and agile, flexible to the independent situations and university relationships we cultivate.

TDP was lean and agile, and transformed quickly based on the project that they handled, mainly because the organization had only three members – Fred worked together with an administrative assistant and a staff member, and occasionally relied upon other MIT faculty for support on specific projects.[74] Steve had been hired as

[73] http://web.mit.edu/mit-tdp/about/ Last accessed February 27, 2012

[74] And yet the TDP had received criticism at MIT for being too insular, and for working with the same faculty members on different projects, rather than involving new people.

the Executive Director for the Technology and Development and the MIT/Abu Dhabi Programs.[75]

When I asked Steve how the Masdar Institute project operated, he explained that the TDP helped reproduce five master's of science programs, which were already functioning at MIT, and provide the students with a certificate, showing that they graduated from a program that was sponsored by MIT. The professors who were in charge of these programs would help TDP in this endeavor. If, for instance, a master's program on Engineering Systems and Management, comprised five core classes at MIT, the same classes would be offered at Masdar Institute as well, with the same content. One faculty member, who had recently finished his PhD and started working with Masdar Institute, explained to me that the syllabi for the courses that they taught at Masdar were imported from MIT as well. If the Masdar Institute faculty member wanted to change the syllabus, she or he would have to let the faculty member teaching the course at MIT know about the decision, and at times provide reasons as to why the syllabus had to be modified. At the end of each year, the TDP would monitor how the students did in each course and compare the results with the students at MIT. Fred told me that the results were comparable, and that in many cases, the Masdar Institute students did as well as their MIT counterparts.

[75] After Steve moved to Abu Dhabi to work as an administrator and chemical engineering professor at Masdar Institute, Duane Boning was appointed as the Executive Director.

In the past decade, scholars in social sciences and humanities have started examining the so-called "global university," that is the emergence of satellite campuses in Asia and the Middle East, specifically by investigating the types of subjects that these branch campuses produce.[76] All in all, these critics spotlight the neo-colonial nature of these university functions, which not only transformed the way in which the North American university related to itself, but also propelled changes outside North American settings.

But for Fred it was important to emphasize that Masdar Institute was not necessarily part of the "global university" model. Despite the fact that MIT was being directly reproduced at Masdar Institute, through curricula, syllabi and control of MIT faculty, it was important for TDP to frame Masdar Institute as an independent institution, different from many other models of building new universities. Masdar Institute would be an independent institution, only initiated with the help of TDP, and promoted by relying on the brand name of MIT. Later it would become a brand on its own, without needing to rely on the MIT name.

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[76] Aihwa Ong, for instance, drew attention to how "the internationalization of the American business schools is most clearly designed to promote a set of American market values, thus shaping the constitution of a particular kind of educated and enterprising subject who works in global cities, that is, a neoliberal anthropos." Similarly, Tom Looser explored the development of a "world citizen" within the expanding networks of universities, such as NYU. "The phenomenon of the global university is becoming a dominant, neoliberal formation of the new millennium, with satellite campuses sprouting up across the continents," Eng-Beng Lim wrote, "It is, in effect, the logical extension of the university's rabid corporatization, the subject of works by many critics." Ong, Aihwa. 2006. *Neoliberalism as exception: mutations in citizenship and sovereignty*. Durham [N.C.]: Duke University Press, Looser, Tom. 2012. "The Global University, Area Studies, And The World Citizen: Neoliberal Geography's Redistribution of the "World". *Cultural Anthropology,* 27: 97–117, and Lim, Eng-Beng. 2009. "Performing the Global University". *Social Text.* 101: 25-44.

But what were the some ways of building new universities that Masdar Institute sought to differentiate itself from? Fred gave examples of institutions in the Gulf:

> There is American University of Sharjah, which was established a la American University of Beirut; that is, it is an American institution, but its campus is in Sharjah...And it is funded by the Sharjah emirate…They may have relationships with different American universities, but those are ad hoc. So the core structure is US-based. American University of Beirut is the same. Its core structure is in New York. So that's one model that I think is working.

The second model of building universities would be, "not universities but colleges that are being established to provide manpower to a particular sector of economy for which they have a major foreign partner – aluminum company, micro-electronics, aviation, these are in Abu Dhabi. That's another model, where your focus is primarily to provide production engineers." He added, "There are models that some universities are working with some parts of the universities on a specific program." As an example for this model, Fred talked about the relationship that Petroleum Institute had with Maryland University, but suggested that it is very narrowly defined. "They are doing their jobs, both sides," he said, "there is exchange."

But for Fred branch establishments were a completely different category, wherein the newly built university would be dependent on the mother institution. In exemplifying branch establishments, he referred to his own alma mater Cornell University, and its Medical School in Qatar's Education City. "Let's assume that Cornell's president in ten years from now says enough is enough," Fred exemplified,

"What will happen to that campus? Cornell hires the people….Students are getting degrees from Cornell. If Cornell doesn't give that degree, where do students get their degrees? So really, except for physical facility, Qatar really has nothing to show. So, that, in my opinion, is not viable for the long run," he reiterated. "Can you imagine if Robert College[77] was established with that premise," he finally asked, referring to the American high school that I graduated from in Istanbul, Turkey. According to Fred, the branch establishment would not provide independence to emergent campuses, but rather hold them hostage under their brand name, their faculty and staff recruitment systems, their diplomas, and curriculums.[78]

On the other hand, Masdar Institute, Steve explained to me, was an emerging independent stronghold of renewable energy and clean technology research in Abu Dhabi. In many ways, he continued, Masdar Institute could be understood as a catalyst that would translate oil revenues into research and development, and as the MIT Technology and Development Program, this evidently was their ultimate aim.[79] Masdar Institute would generate new science and engineering knowledge for the

[77] Robert College, the oldest American school outside the United States, was established in 1863. Its founders were Christopher Robert, a wealthy American philanthropist, and Cyrus Hamlin, a missionary with a special interest in education.

[78] This independence would also leave wiggle room to both mother and branch institutions, allowing both to assert their own understandings of politics and ethics of pedagogical practice. In the case of NYU-Abu Dhabi for instance, issues such as the admission of Israeli students or faculty members had become problematic, requiring both sides to negotiate on whose principles would be enacted within NYU-Abu Dhabi – NYU's or Abu Dhabi's?

[79] Interview with Steve Griffiths, February 16, 2010.

region and the globe, eventually triggering the expansion of a knowledge-based industry, Steve said, similar to Silicon Valley or Boston 128.

Knowledge of renewable energy and clean technology epitomized by Masdar Institute would be a centerpiece for transforming Abu Dhabi's resource-based economy into a sustainable knowledge-based model. "Oil is exportable, while the sun is not," Steve curtly stated, thereby spelling out the seemingly most significant difference between the two kinds of energy-based business activity. "Well," he continued, "the two resources are disconnected in the sense that the former is easily capitalized upon while the latter cannot contribute to the production of goods immediately." The massive infrastructure – oilrigs, refineries or pipelines – that enabled the production and distribution of oil, were now to be developed for the production and distribution of solar energy. "Masdar City will help create indigenous firepower to make these industries grow," Steve concluded, "and so Abu Dhabi will get into places where they become elite." The knowledge produced through Masdar Institute would enable Abu Dhabi to enter into new relationships, holding the position of a center of innovation, rather that oil-exporter.

**Beautiful Buildings**

In producing the knowledge-based economy, it was also significant that the UAE would become a regional and global center for research related to renewable

energy and clean technology. The government could thus provide incentives, such as tax breaks, for companies to open up their research and development branches within Masdar City. At the same time, Masdar Institute had to attract students from around the region, who would upon graduating from the Institute participate in entrepreneurial activities. These entrepreneurial activities would make the region livelier economically, thus contributing to the materialization of Silicon Valley or Boston 128 ideals, thereby the knowledge-based economy.

In line with these future goals and prospects, in December of 2010, Fred approached me to ask if I would be willing to help organize a student recruitment trip to elite Turkish universities. He had recently met the president of Middle East Technical University (METU), and found out that a large percentage of their graduates seek out graduate degrees outside the country, mostly in Europe and the United States. He wondered what other universities in Turkey would be similar, and asked me to select campuses where Masdar Institute should make presentations in order to attract and recruit highly-qualified students. I volunteered to assist with the project. In mid-February, right after the beginning of the second semester, I traveled to four leading Turkish universities, together with two other Turkish nationals affiliated with the Institute. While Eda and Elif presented the introductory slides that had been provided by the public relations unit at Masdar Institute, and shared their respective experiences, I took notes and photographed their interactions with audience members for a report that we would write upon our return to Abu Dhabi.

We stayed in Turkey for about a week, and visited METU and Bilkent in Ankara, and Boğaziçi University and Sabancı University in Istanbul.


Figure 7 Masdar Institute Slides from Recruitment Presentation: Living Laboratory

When presenting Masdar Institute in these universities, our team made extensive use of the images of the eco-friendly campus, promoting its experimental infrastructures, its well-equipped laboratories and its pod cars. Masdar Institute was not only a beautiful building, but also "a living laboratory" where research on renewable energy and clean technology could be experimented with real-time. The validation of specific knowledges on renewable energy and clean technology thereby became a performance, wherein the site of knowledge-making somewhat became the experiments that it housed,[80] or rather, constituted a "living laboratory." If the

[80] Galison, Peter, and Emily Ann Thompson. 1999. *The architecture of science*. Cambridge, Mass: MIT Press.

students chose to come to Masdar Institute, their everyday would be shaped by the experimental infrastructures of the Masdar Institute campus, providing them with a learning opportunity at every point.[81] For Masdar Institute students, living and breathing these technologies had to become an important aspect of embodying them, making the campus an essential part of their education.

While the Institute organized recruitment events around the world,[82] attempting to create a diverse student body within the eco-friendly campus, the students who attended Masdar consistently compared it to another emergent regional stronghold, King Abdullah University of Science and Technology (KAUST). KAUST had been opened on September 23, 2009, roughly a month after the opening of Masdar Institute. By establishing KAUST, King Abdullah sought to generate technological expertise and to diversify Saudi Arabia's economy, thereby safeguarding the post-oil future.[83]

Masdar Institute and KAUST were very similar national development strategies, emerging from two oil-producing countries, for a time when there would

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[81] As Timothy Choy argues in describing environmental activists in Hong Kong, "environmentalism, if we may name such a thing, is not simply about what one knows. It is rather a way of forming and situating oneself in the world – in relation to nature, to the planet, to science, to human beings, and to other living and non-living forms." In this sense, Choy shows that environmentalism is about "the cultivated details of living." Choy, Timothy K. 2011. *Ecologies of comparison: an ethnography of endangerment in Hong Kong*. Durham [N.C.]: Duke University Press

[82] http://www.thenational.ae/news/uae-news/environment/masdar-institute-in-us-student-recruitment-drive Last accessed February 23, 2012

[83] Discussing the inauguration of KAUST, Toby Craig Jones writes: "[King Abdullah's] focus on science and technology, and his use of oil wealth to build up local expertise, which the king hopes will ultimately help the kingdom diversify its economy, establish a foundation for a future after oil, and make Saudi Arabia internationally competitive in science, are signals that these areas should figure prominently in how both Saudis and outsiders think about the kingdom…"Jones, Toby Craig. 2010. *Desert kingdom how oil and water forged modern Saudi Arabia*. Cambridge, Mass: Harvard University Press.

be no more oil resources to exploit.[84] But Masdar Institute students were more interested in the KAUST campus and opportunities. "Did you know that the KAUST campus has three pools," one student told me, "I've heard that they have better scholarships as well." He explained that he had come to the UAE, because it was more liberal than Saudi Arabia, but he pointed out, "You know, I've heard that KAUST is like an oasis, it's not like the rest of Saudi Arabia, it has a beautiful campus, beautiful buildings, something like a forest in the middle of the desert." And how exactly did this site of knowledge-making contribute to the performance of a knowledge-based economy?

Adi Ophir and Steve Shapin[85] argue, "The place of knowledge is implicated in the network of relations between knowledge and power, in the distribution of knowledge in society, in perceptions of its validity and legitimacy…And, even more fundamentally, identification of the place of knowledge is part of any inquiry concerning the ontological status of scientific objects and the epistemological standing of scientific statements. The place of knowledge lays down conditions for the appearance of the objects of science, for their validation as real, and for the terms on which they are knowable." Taking a Foucauldian perspective on power/knowledge,

[84] I would like to point out, however, that while KAUST served to generate legitimacy for the Saudi regime inside the country, Masdar Institute targeted an international audience. As such, in their relationships with the local populace, the projects differed drastically.

[85] Ophir, Adi and Steven Shapin. 1991. "The place of knowledge: A methodological survey." *Science in Context* 4(1): 3-21.

Ophir and Shapin situate the place of knowledge amongst the constellation of conditions, which produce knowledge of a particular variety.

On the other hand, Nigel Thrift[86] suggests that such "performative" buildings "are meant to encourage a certain notion of interactive knowledge." By creating continuous flows of people and ideas within the building, what "comes into existence is an attempt to socially engineer the process of scientific discovery, using the physical environment as a resource but not as a determining factor." According to Thrift, one way to provide this resource is by organizing the building in such a way that it creates "a buzz" amongst the scientists who are working there. In this sense, for Thrift buildings are a resource, which contribute to the scientific community in different ways.

While helpful in understanding the place of knowledge in the formation of knowledge, neither of these perspectives offers tools to understand the ways in which places of knowledge interact with the world outside their walls. In other words, neither of these perspectives attends to the relationality of the buildings, and to the ways in which they perform to outsiders.

However, in the case of Masdar Institute, or in other set-ups that seek to represent knowledge-based economies, such as the KAUST campus, or the Guggenheim, Louvre or NYU-Abu Dhabi buildings on Abu Dhabi's Saadiyat Island,

[86] Thrift, Nigel. 2006. "Re-inventing invention: new tendencies in capitalist commodification". *Economy and Society*. 35 (2): 279-306.

the buildings were means through which relations would be cultivated with outsiders. In this sense, the buildings more importantly strived to create a buzz outside their walls. In this sense, they attracted attention to the knowledge-based economies emerging in the Gulf, and served as material proofs of their promised interest in knowledge infrastructures. Through their processes of design and construction, and later advertising and promotion, the buildings embodied and performed the knowledge-based economy in a manner that could easily be communicated to spectators.

As such, the buildings were means of transforming the relationships that the UAE already had through its oil-export economy, giving them new, and more sophisticated, qualitative dimensions. In other words, it was not the buildings, but their relationality that mattered in creating an economy of innovations.

**A History of Knowledge-Making**

In a similar manner in which the Masdar Institute students talked about KAUST buildings, Fred had found it necessary to refer to the beautiful building of the new center they help set up in Cairo University.

TDP's project with Cairo University had been initiated in 1977, at a time when development models were beginning to stress knowledge and capacity building and

giving up grassroots infrastructural projects.[87] "So in Egypt, it was just the time that the Camp David Accord was signed between Anwar Sadat and Menachem Begin," Fred started narrating the story of their partnership with Cairo University. "And the US President, Jimmy Carter was very interested in turning that cold peace into a hot peace, so he asked us to see whether we were interested in working with institutions in Egypt, and we agreed," he noted, "so we worked with Cairo University for about ten years, eleven years." Their partnership mainly consisted of collaborative research projects between MIT faculty and Cairo University faculty, and was supported by USAID.

"The program had three main benefits," Fred said. First, if a faculty member at MIT had a project proposal that was related to Egypt, they could easily find faculty members to partner with at Cairo University, a large public university, and pay them through the TDP funds. Second, the kinds of project a faculty member could research in Egypt were very different from those available in the United States. "For example the impact of subsidized housing," Fred exemplified, "the impact of government commitment to provide housing for every family and not being able to deliver, what happened to that market…Or for example, the Aswan Dam, which at the time was being run by the Ministry of Agriculture." However, this agreement

[87] For in-depth studies of development in Egypt, see Elyachar, Julia. 2005. *Markets of dispossession: NGOs, economic development, and the state in Cairo*. Durham: Duke University Press, and Mitchell, Timothy. 2002. *Rule of experts Egypt, techno-politics, modernity*. Berkeley: University of California Press.

would also have unexpected structural impacts on the way Cairo University was organized.

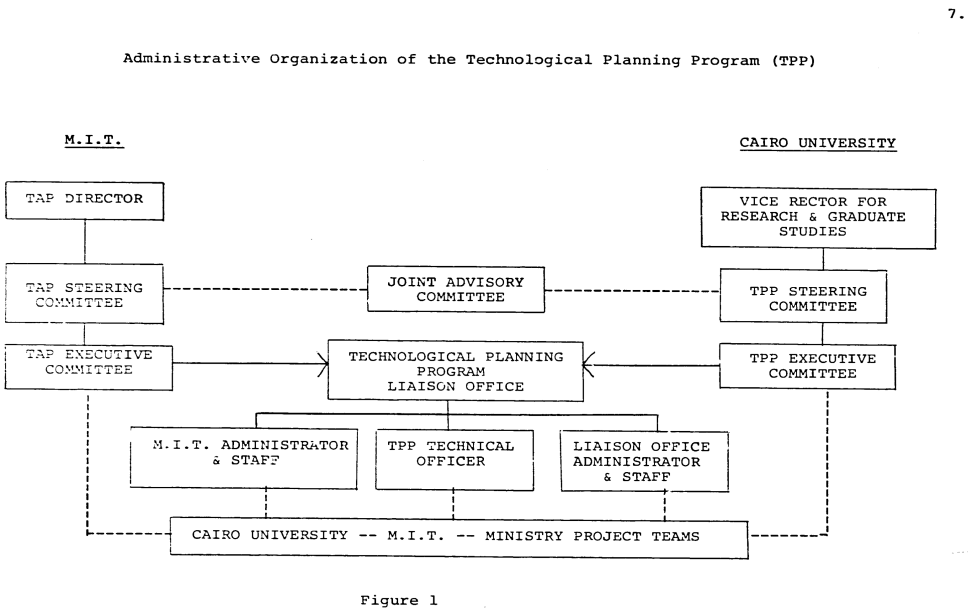


Figure 8 Organizational Chart of Cairo University and TDP Collaboration

Thanks to this experience, Fred said, the TDP learned more about how the university operates in "socialistic" regimes, and contemplate questions such as, would you educate masses of people with lower standards, or would you educate only a few with very high standards? Along with such large-scale questions, there emerged more practical problems as well. "For example, at MIT, when you have a research contract, you pay MIT an overhead for its infrastructural support," Fred explained. They had decided to apply the same rule in Cairo University, and pay them overhead for costs incurred in the general upkeep of the project. But the Cairo University administration did not operate in this manner. "First of all the administration did not quite

understand what the heck is the overhead," Fred noted, "Why are they giving us the money for nothing?" Then there was the problem of what to do with the overhead from MIT. Fred continued,

> There was no bank account. Cairo University with 120,000 students had no bank account. Everything was coming from the government. So they told us we had to put the money in the government account. We said, "We're not going to do it." We had to go all the way to Sadat, get him to write a decree, that Cairo University is allowed to open up a bank account. So they opened a bank account. The question came up who are going to have the right to sign it. Well, the president didn't want it. He didn't want to get accused of writing checks. So we finally agreed two people have to sign the checks. Quite an interesting scene... And believe it or not, they did not spend a nickel of that money. They didn't want to be accused of anything. They were so afraid of MIT, US government… They had all this elements of explosion. Finally we convinced them. They had accumulated several million dollars, so we told them that they should build a building for the center, which is a beautiful building. It is still there. It is still operating. And ironically that is the only center in Cairo University that is allowed to enter into contract with an outside board. The last time that I was there, the president of it was telling me that the government charges them overhead!

Through Technology and Development Program's intervention, this new section of Cairo University had transformed from an institution that relies on government funding to an independent institution, which can enter into contracts with outside parties, and set up "a beautiful building" that would house such operations. This would open the way for contract-based research as well, wherein teams of researchers would be able to provide services to private entities. The USAID report on the

project[88] also suggests, "The Center for Development Research and Technological Planning has been established at Cairo University. This center is an autonomous unit, which has its own bylaws and is free from regular governmental financial and administrative regulations. A director and a board of directors have been appointed. An organizational structure, administrative and financial procedures have been developed. The scope of the Centers interest is broader than that covered in the Cairo University/M.I.T. Technological Planning Program and has the capability to reach all areas related to development plans for Egypt. Additional time and experience with the Center operation will be necessary in order to fully evaluate its contribution." The "socialistic" university had thereby begun to emulate the perhaps non-socialistic US model, wherein contracts with outside parties, managed from the beautiful building, was slowly becoming the modus operandi for conducting research projects.

After this long project with Cairo University, TDP would sign another higher education related contract with American University of Beirut (AUB), a private university in Lebanon, this time not funded by USAID. Fred told me that the then-president of AUB, Dr. Fredrick Herter had contacted TDP, suggesting, "I have heard of your work in Egypt, and can you help us, because this is the war time in Lebanon, and our faculty are really trying to leave, and I want to save them, so can you bring

[88] See Evaluation Of The Technological Planning Program Cairo University/Massachusetts Institute Of Technology Aid Contract NE-C-1291 http://pdf.usaid.gov/pdf_docs/PDAAM411.pdf Last accessed February 20, 2012

them to MIT and put them to work with some of the MIT faculty for any lengths of time so that their research activities will continue." Fred asked Dr. Herter where the funding for this project would come from. "So he brought this guy at the time, his name is Rafiq Hariri, who then became the prime minister. But at that time he was just a rich man. He came and he talked and I remember Pat (a TDP staff) talked to him, he said how much does it cost, Pat said I don't know exactly but roughly about 10 million dollars, and he said, who do I write the check to? We said, "We have our own bureaucracy. We have to prepare a proposal, submit etc." So we did it, and they gave us some money. It went on for about 4-5 years, going back and forth. We didn't go there, we couldn't go there. It was the war. Many of these people now are in the cabinet; of course Hariri himself became the prime minister. His son, who is now the prime minister, was here. So it left a very nice impact," Fred concluded. Both in Egypt and in Lebanon, knowledge channeled by TDP was utilized to maintain and cultivate foreign relations between the United States and its Middle Eastern counterparts.

Next, Fred turned to the beautiful buildings of Kuwait University. The TDP's next project in the Middle East would be in Kuwait, with a primary focus on economic and technological issues. "The university was a mess," Fred noted, "They had beautiful buildings, ironically Saddam cleaned them out completely, even the air conditioning plates were gone, but it had become Balkanized, in the sense that there was an Egyptian clique, Algerian clique, Palestinian clique, different groups had their

own cliques." These cliques had been united against Kuwaitis, especially because every young Kuwaiti PhD would immediately be hired with full tenure, and sometimes become appointed as department chair. TDP tried to reconfigure the university's social life, while contributing to research projects. Soon after the war was over, however, TDP went back to work in South America, in Argentina and Brazil, and then Malaysia, Thailand, and then arrived back in the Middle East with Masdar Institute.

Talking about first the beautiful buildings of Cairo University and next how the Iraqi army had cleared out the air-conditioning units within Kuwait University, Fred sought, on the one hand, to underline the way TDP's work "beautified" knowledge by paying overhead to Cairo University, and on the other hand pointed to the violence towards knowledge enacted during the Gulf War. The buildings served as fruitful metonymies.

Yet throughout these projects, Fred told me, TDP transformed, partially because the staff learned how existing bureaucracies in these universities could be major barriers to administer the intended transformations. "So rather than trying to change a system that had tremendous inertia," Fred said, "We thought it's easier to create a new system. Of course, that creates its own problems." That was why they wanted to start new university projects first in Malaysia and Thailand, and now in Abu Dhabi, with Masdar Institute.

In concluding our conversation, Fred emphasized how, in all these years, the TDP staff had learned that the institutions that they set up had to become "independent, privately controlled, rather than government controlled." Fred finally noted, " and we have to give them, in my opinion, one of the most exciting features of the American university system; the notion of contract research."

**Contract Research**

Throughout the two years in which I knew him, first in the capacity of TDP president, and starting in August 2010, as the new president of Masdar Institute, Fred reiterated that contract research fostered competition, allowed for multiple channels for seeking funding, and encouraged innovation.

"In Britain, they have university grant commission," he exemplified, "And the university grant commission system gives grants, it's not much, but since all the salaries of the faculty and all the fees of the students come from the government, these grants are used for buying equipment, doing some tests… All you have to do is write a short proposal…It does not create a certain competitiveness." As such, Fred understood the availability of government funding for the university as a seeming disadvantage.

"In the US," he continued, "we by and large do not have a university grant commission, and the money is primarily distributed on a competitive basis. I write a proposal to National Science Foundation, you write a proposal to National Science

Foundation. They decide which one of them to fund. I write a proposal to IBM, you write a proposal to IBM. IBM negotiates. This is what I want! If I can do it, I incorporate." In this system, where researchers did not automatically receive funding from the government, Fred argued, "there is a lot of dialog between faculty and the sponsor. At the same time, there is a lot of awareness on the faculty side regarding what's happening to these sponsors. I joke with many MIT presidents that with all the respect to them, they're not all that important to me, because my sponsor is much more important. My sponsor pays for my summer salary, my office, my computers, my telephone, my secretary, and my coffee. All of that comes from contract research! So I have to be worried about my sponsor, to keep him happy! I have to be aware of his needs. I have to identify that. It creates a very different relationship between university and society. That model doesn't exist [in the rest of the world]. To create that, takes a lot of effort."

In setting up Masdar Institute as well, the contract research infrastructure was a priority for TDP. While the Abu Dhabi government would pay for the formative stages of the Institute, they wanted to have a separate research budget as well, which would be distributed on the basis of proposals. "A proposal not only addresses the need, but it creates obligation," Fred stressed, "I'm going to do it, it takes this much time, it takes this much money, and these are my deliverables, and at the end you have a right to review, and tell me whether I did a right job or not. That is a very different

mindset, especially that the students get involved." This was the mentality that they sought to create.

On the other hand, the researchers and faculty at Masdar Institute contemplated the impact of contract research prospects on their individual careers. For instance, Michael, a post-doctoral researcher who had been recruited as a faculty member, told me how he was eager to explore opportunities at MIT during the one preparatory year he was expected to spend there, before beginning his term as an assistant professor. He thought he should concentrate on microbial communities and explore fundamental research. Yet he did not know how the Masdar community would take it, especially because data mining in regards to microbial communities may not have immediate commercial impact. "Masdar's future prospects involve developing partnerships with companies and receiving finances for research projects – even at MIT they all have their start-ups on the side," he said, "but for the time being I'm not interested in that, I just want publications." While he did not mind participating in a competitive research infrastructure, where he would submit proposals and expect to receive grants, Michael was worried that conducting fundamental research would be difficult at Masdar Institute.

Besides engaging in joint research relations with Masdar Institute, different corporations, such as Siemens, BASF, Bayer or General Electric, were encouraged to start research units within Masdar City, contributing to the flourishing of the eco-city as a clean technology cluster. One of the post-doctoral researchers at the Institute

explained to me how a similar strategy had been used in setting up themed clusters in Dubai. "For instance, in Dubai's Media City, they just gave a building to CNN for free, and all the other media companies had to follow and open offices in a zoned area next to that building. The strategy that they're using in Masdar is similar," she noted. In this sense, contract research would not only help advance specific research projects, but would also help set up a space dedicated to such experimentation, thereby creating stronger ties between the industry, the academe and the government. The contracts were then expected to embody relationships, enabling a flow of information between the three parties that Fred identified. Consequently, Fred argued, contract research would transform society.[89]

One such research contract between Masdar Institute and General Electric, which materialized in the fall of 2009, specifically concentrated on the development of "the kitchen of the future," wherein General Electric would collaborate with Masdar Institute in testing smart grids and smart appliances (see chapter 3).[90] However, the collaboration between Abu Dhabi and General Electric was not restricted to this research contract. In addition to helping build "the kitchen of the future" within

[89] I asked Fred what would happen to the humanities and social sciences under this model. How would they receive funding in the absence of public support? Was it possible to conceive of a humanities program, working together with the industry? Fred suggested that media organizations, such as History Channel, could support research by academics from these disciplines, thereby recommending a way of including them within corporate structures.

[90] http://www.greenchipstocks.com/articles/ge-moves-smart-appliance-testing-to-masdar-city/851 Last accessed February 22, 2012

Masdar Institute, and starting an "Ecomagination Center" inside Masdar City,[91] General Electric benefited from the Sovereign Wealth Funds (SWFs) that the Abu Dhabi government made available through the Sovereign Wealth Fund Institute.[92]

SWFs are state-owned long-term investments in the global assets of a company, which may be utilized as a tool for fostering national development. In building research alliances for Masdar Institute as well, the SWF had proved to be influential. Mubadala, the larger company that started Masdar, had recently invested a SWF in General Electric, buying less than 10% of General Electric, thereby starting a mutual long-term financial relationship. As part of this relationship, GE was expected to invest in research in Abu Dhabi, and help the Emirate's technological development. "The kitchen of the future" or "the Ecomagination Centre," then, was only an externality or overflow of a much larger deal that was taking place at another, possibly higher, level. As a short note in one press release suggested, "The Ecomagination Centre is a product of the GE and Mubadala framework agreement, signed in July 2008, on a global partnership encompassing a broad range of initiatives including commercial finance, clean energy research and development, aviation, industry and corporate learning. Building on an already strong relationship and a common view of high growth opportunities in the Middle East and globally, the agreement provides for

[91] http://www.guardian.co.uk/business/2008/jul/23/generalelectric.sovereignwealthfunds Last accessed February 22, 2012

[92] Haberly Daniel, 2011, "Strategic sovereign wealth fund investment and the new alliance capitalism: a network mapping investigation" *Environment and Planning A* **43**(8) 1833 – 1852

shared capital commitments to new joint ventures and investment funds."[93] In some ways, Abu Dhabi's own funds were being directed to Masdar Institute, branded as General Electric. So, as much as Fred believed contract research would foster ties between industry, government and academe, what Masdar's research contracts initially demonstrated was a reliance on the ties that were already built through Abu Dhabi's oil wealth, and which were now being utilized for the production of a knowledge-based economy.

In these ways, the research contracts were comparable to the beautiful buildings, which were springing up in emergent knowledge-based economies, such as the UAE. In the same way that these buildings would serve as alibis for how the UAE was investing in a future of innovation, contract research was to create cohesion amongst the government, the industry and the academe, thereby demonstrating the step that the UAE was taking towards the constitution of a knowledge-based economy. Both research contracts and buildings would reformulate relationships, inside and outside the institutions in which they were being produced. In this sense, it was not the research contracts or the beautiful buildings that mattered for the constitution of a knowledge-based economy, but their respective relationalities.

[93] http://www.genewscenter.com/content/detailEmail.aspx?NewsAreaID=2&ReleaseID=5862&AddPreview=False Last accessed February 22, 2012

**Relationships / Knowledge / Relationships**

All in all, the establishment of Masdar Institute not only gave rise to new knowledge through the relationships that it relied upon, but also produced new relationships through the knowledge that it produced. In further evidencing this movement, Sultan Al-Qassemi[94] an Emirati journalist, writes in *The National*:

> In order for this vision [of the knowledge-based economy] to be fully realised, it is important to create a network in which the above knowledge hubs interact and compliment each other rather than exist in isolation. This network should ideally be built in layers, connecting first the hubs in Abu Dhabi with each other, and then branching out across the country and into the wider Arab World…But how would such a network operate? The leaders of these various knowledge hubs must familiarise themselves with each other, along with the heads of universities and even high schools. They could do so by meeting periodically to share expertise and ideas and keep each other updated on future plans. In this way, students in Abu Dhabi will be able to study in world-class universities, undertake internships in world-class institutions and perhaps carry out research in Abu Dhabi's strategic industries. Secondly, these knowledge hubs must launch community outreach programmes to make sure that their benefits reach a wider audience, while also amassing a coalition of stakeholders who are keen on building a knowledge-based future. NYU Abu Dhabi has already launched a successful free public lecture series that feature top professors. By reaching out to others, Abu Dhabi's knowledge hubs can function as musical instruments that, when played together, create the effect of a harmonious symphony.

The new economy of Abu Dhabi would be an outcome of these relationships, here described as a "harmonious symphony." In other words, it was the relationality of

[94] http://www.thenational.ae/featured-content/channel-page/news/uae-news/middle-conversation-columnists-articles-list/linking-capitals-knowledge-hubs-can-fulfil-its-vision Last accessed March 21, 2012

Masdar Institute, along with other universities and museums mushrooming in the region, which would elicit novel forms of knowledge and economic value.

In further explaining this vision, Anand, an executive at Masdar Carbon asked me, "Have you heard about Kizad, a 470 m2 industrial area in the outskirts of Abu Dhabi?" and recalled that it is going to be the largest industrial zone in the world. "Through Masdar, Abu Dhabi builds relationships," he said, "and through those relationships it will fill these industrial zones. These industrial zones will be the real alternative to oil." According to him, Abu Dhabi would import raw materials, produce by relying on cheap labor, and then export commodities. In this process, Anand underlined, it would have many partners to work with. This was the kind of diversification that would take place. Such developments would change the country's face. Specifically through developments like Masdar Institute, Abu Dhabi would enter these relationships not as an oil-producing economy, but rather as a center of innovation, thereby becoming "more elite."

In the next two chapters, I will examine the making of experimental infrastructures within Masdar City, which were meant to produce sustainable habits for the residents of the eco-city, first by detailing the development of an energy currency and next by discussing the implementation of a personal rapid transit (PRT) system.

## CHAPTER THREE:

## ERGOS: A NEW ENERGY CURRENCY

### Presenting

Alexander, an assistant professor at Masdar Institute, presented his recent research paper to an audience of faculty members, post-doctoral researchers and students in a spacious classroom on the new eco-friendly Institute campus, only a few weeks after the fall semester began.

"The way we understand the economy," he said, "is based on a decoupling; a decoupling of the economy and the physical world." Pointing out how "money is a belief about a belief generated by debt in a fractional reserve system," he argued that it was time to make monetary exchange more tangible. Accordingly, his research paper aimed at bringing "the economy and the physical world" together through a new currency based on energy consumption. "In order to link the economy to the physical world, why not have an energy ticket for every service that is provided? Use energy as a currency? Could this be a universal currency?" he inquired, rhetorically.

Then he revealed the system that he and his colleagues at Masdar Institute had been imagining. Inhabitants of Masdar City could routinely be issued a balance of energy credits called "ergos," etymologically signifying "work" or "action," which would define their pre-allocated energy budget over the validity period of the credits.

A single credit would represent the right to consume a physical quantity of electricity (e.g. 1 kWh) and have a defined expiration period (e.g. 1 month). If the ergos account of any user ran down to zero, electricity would be consumed by buying ergos at spot market price. If a consumer used exactly the same amount of electricity that had been allocated, he or she would not be subjected to the credit spot price, which was expected to be substantially higher than the subscribed price. Accounts would be filled with energy credits at the beginning of each validity period, and diminished or increased commensurate with the user's practices. "Everyone has to be part of it" Alexander underlined, "otherwise it does not work."

In some ways, Alexander's project meant to restore the gap that Philip Mirowski[95] laid out in his book *More Heat than Light*. According to Mirowski, founders of neoclassical economics had borrowed the concept of energy from nineteenth century physics, thus eventually formulating the concept of utility. In doing so, these economists had actually overlooked the multiple discrepancies between energy and utility. One such discrepancy Mirowski delineates is how energy conservation cannot be translated into an economic concept when studied within the boundaries of utility theory. As such, Mirowski constructs a lens that enables him to expose the flaws of neoclassical thinking, from its very beginnings. But what happens when utility is taken out of the equation, and is directly replaced with energy? Could this be

[95] Mirowski, Philip. 1989. *More heat than light: economics as social physics, physics as nature's economics.* Cambridge: Cambridge University Press.

perceived as an intervention in neoclassical economics, or perhaps serve to link the "economy" and the "physical world" as Alexander aspired?

In this imaginary, ergos would give Masdar City a particular independence, especially because the energy consumed within the city limits would also be produced by the renewable energy power stations connected to the city. The amount of kilowatt-hours of energy produced on site would have to correspond to the amount of ergos reserves that would be available to Masdar City residents. In this way, Masdar City residents would only consume the energy that they would have the capacity to produce. Setting the eco-city apart from other renewable energy generation and consumption projects that make use of large networks, such as DESERTEC,[96] Masdar City's ergos would contribute to situating the city as a showcase for decentralized energy systems.

One of the post-doctoral researchers at Masdar Institute denied ergos such potential, and suggested that it was mostly constituted as a tool for creating awareness on energy efficiency issues. In this way, she said, people will have a better sense of how much energy they are consuming. "At the end of the day, ergos is just a derivative of any available energy unit. So we must still think about how useful or necessary it is to create yet another artificial measure," she concluded. She thought that ergos would mostly serve as a discursive instrument.

[96] DESERTEC promotes the production of electricity through solar and wind power stations constructed in North Africa and the Middle East, and suggests that this energy could satisfy the energy needs of many regions including Europe. For more information on the project please see: http://www.desertec.org/ Last accessed December 22, 2011

In the question and answer session of his presentation, Alexander clarified that ergos would still function within market dynamics; there would be price volatility, and therefore value to be gained. Of course, initially ergos would operate together with the UAE dirham, especially because the inhabitants of Masdar would be paid in dirhams. Since Masdar City was still not a completely self-sustaining eco-city, and since the people who live in Masdar would be required to purchase goods outside the ergos zone, they could not just abolish dirhams. It would be best if ergos could become a universal currency, Alexander explained. This is what they aimed at, eventually.

In this chapter, I explore how researchers and professionals working on imagining and implementing novel energy infrastructures, in this case the new energy currency ergos, related to the potential consequences of their work. I therefore study the ways in which ergos became imagined and implemented, while the potential social implications of the project remained somewhat sidelined. Accordingly, I show that in order to be able to imagine ergos as an infrastructure, researchers initially needed to put two other related systems into practice. As such, I first investigate the implementation of the Intelligent Building Management System (I-BMS), which was crucial to monitor energy production and consumption within Masdar. Here, I draw upon meetings with representatives from the BMS subcontractor Schneider Electric, energy efficiency engineers at Masdar City, and researchers from Masdar Institute, in addition to participant observation with students and post-doctoral researchers, to

chart the problems with setting up this essential facility. Second, I look into the plans for the Masdar Institute Demand and Response Study, which would be started only after the BMS was fully functional. The Demand and Response Study aimed at testing energy consumption amongst Masdar students, to finally come up with a set of incentives for promoting energy efficiency, thereby mapping out the conditions in which ergos was being implemented. I conclude with how these stages, and the eventual implementation of ergos as a currency, became crucial for defining Masdar City as a "strictly zero-carbon," "zero-carbon," or "carbon neutral" city.

In studying these steps, I seek to underline how the challenges embedded within the production of these technical layers sometimes muffled the larger questions regarding the social or ideological meanings of the research project. While the technical details of implementing these intermediary infrastructures remained the focus of everyday conversations and practices, the Masdar Institute students became reproduced as subjects within a series of ever-evolving experiments. An abstract good, framed as an act of helping humanity in confronting energy and climate challenges, served to justify the possible problems emerging from a technologically complex energy regime. All in all, the potential paradoxes of the project were passingly acknowledged, but not directly confronted.

**Technocratic Dictatorship**

At the end of his presentation Alexander clarified that he is aware of the potential social implications of their proposed project. In order to track energy consumption through ergos, every individual would be assigned a code, and would have to use that code in order to access electricity in public spaces, such as when taking the elevator or charging a laptop at the library. Through ergos, every individual's consumption patterns would be traced at every point in time, as long as he or she remained within the boundaries of Masdar City. After pointing out that commitment to energy constraints could lead to a form of "technocratic dictatorship," Alexander asked if we could "maintain freedom of action, promote equality, and meet resource constraints," while utilizing technology towards increased energy efficiency.

A post-doctoral researcher that I later spoke with also argued that ergos has a "Big Brother side" to it, suggesting that a utilities company could study a consumer's appliance/electricity consumption ratio, develop a better sense of the consumer's habits, and sell this information to vendor companies. This information would easily reflect and include private data about a consumer's everyday life. At the end, it would comprise a highly detailed surveillance mechanism, charting how and when and how long any appliance in a household is utilized.

In this way, the researchers working on the experiment of building an energy currency explicated how their proposal could be socially and politically problematic,

but eventually put their hesitations aside.

## Energy Theories of Value

And yet Alexander and his team were not the first ones to come up with an energy based currency system, which would tie Masdar City inhabitants together, like any other currency that connects citizens of a country within porous boundaries.

Writing in the 1930s, with the purpose of recommending solutions for the economic depression in the United States, Howard Scott, the founder of the Technocracy Movement, argued, for instance, "To say it in one way, the cause of our troubles lies in the fact that during these years, instead of thinking of our well-being and of the operation of our country in terms of energy, we have thought of it in terms of something purchasable with dollars. If we are to understand the problem at all we have got to grapple with this question of energy; upon it everything else rests."[97] Furthering his argument, Scott stated,

> It is the fact that all forms of energy, of whatever sort, may be measured in units of ergs, joules or calories that is of the utmost importance. The solution of the social problems of our time depends upon the recognition of this fact. A dollar may be worth -- in buying power -- so much today and more or less tomorrow, but a unit of work or heat is the same in 1900, 1929, 1933 or the year 2000.

The Technocracy Movement thereby suggested that energy, given its stability throughout years, should replace the dollar, and be put into use as a currency.

[97] Scott, Howard. 1933. "Technology Smashes the Pricing System." *Harper's Magazine*. [New York]: Harper & Brothers.

According to this proposal, the net energy budget of the United States would be calculated and divided amongst the residents of the highly centralized "North American Continental Technate," providing an energy certificate of "joules" or "ergs" to the residents of the continent. These non-transferable credits would expire after a period of two years. As William Akin[98] posits, Howard Scott believed that "his system would assure the goals that the technocracts desired: to restore purchasing power, assure maximum distribution of all goods produced, balance production and distribution, and abolish debts and profits." As such, the economic crisis would be managed by what they referred to as apolitical engineering solutions.[99]

As Akin states, "In the minds of the technocratic planners, the rationality of science and the harmony of the machine, not utopian virtues, would dictate organizational forms." However, the rationality of science and the harmony of the machine could only be achieved through specific social and psychological transformations. First of all, the human would have to accept that she or he is a machine, through precise conditioning methods. Akin[100] writes,

> Since the basic need of society was technical expertise, their education system would abolish the liberal arts, which stressed outmoded moralistic solutions to human problems. It would essentially replace the humanities with the machine shop. In the process, members of society would be conditioned to think in terms of engineering rationality and efficiency. Man, in short, would then be conditioned to assume the character of machines, to accept "a reality understood in terms of

[98] Akin, William E. 1977. *Technocracy and the American dream: the technocrat movement, 1900-1941*. Berkeley: University of California Press, p. 84

[99] I thank Ronald Kline for encouraging me to read about the Technocracy Movement.

[100] Ibid, p. 142

machine-like functions."

In this way, the technocrats would eliminate religion, fine arts, and humanities along with all other possible kinds of intellectual activity. For them, these nonproductive acts would have no function within the upcoming era of technical rationality, organized around an energy theory of value.

Philip Mirowski[101] calls movements like Howard Scott's, which seek to show how energy is identical to economic value, "neo-energetics," and differentiates them from others who have been interested in energy as a metaphor for constructing economic principles. "The conviction that there exists a literal identity between the physical concept of energy and the economic concept of value…has a long and illustrious history, dating back to the 1860s," he adds, and explains how neo-energetics "has not been confined to obscurity, but has always enjoyed a certain visibility within the scientific community." According to him, two major reasons why neo-energetics has been able to survive for so long is that "one, that the energy theory of value was never developed with any seriousness or concerted effort…and two…it never resided very long within any academic disciplinary boundaries, but rather hopped about peripatetically from one fledgling discipline to another." As such, Mirowski argues, a lack of rigor, along with multidisciplinary interest in the subject

[101] Mirowski, Philip. 1988. "Energy and Energetics in Economic Theory: A Review Essay". *Journal of Economic Issues.* 22 (3): 811-830, p. 812.

was the main factors contributing to the popularity of energy theories of value.[102]

But what do the energy theories of value have to say about the concept of value? In modern theories of neoenergetics, energy is analyzed as a common denominator for all commodities, just like labor would be for Marxist economics. Berndt,[103] a somewhat promoter of modern day neo-energetics, explains,

> First, much like Marx's labor theory of value in which all commodities represent congealed labor, in the accounting sense commodities can be measured by the direct energy input into their production plus the indirect energy input embodied in capital, material and other inputs. The second sense in which energy tends to be viewed as embodied or sequestered in materials is as thermodynamic potential. From the basic principles of physics and chemistry, it is known that materials have thermodynamic potential which changes as the materials pass through various states in productive processes, encountering heat energy and/or work.

In a similar vein, Robert Costanza a prominent neo-energeticist suggests,[104] "Can anyone seriously suggest that labor creates sunlight! The reverse is obviously more accurate." In calculating how energy would correspond to value, neo-energeticisits also utilize various formalisms, and look for ways of sorting out "embodied or sequestered energy" within commodities. In doing so, the movement argues that it is

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[102] Anthropology has also been one of the disciplines to underline the significance of energy theories of value, while providing an interpretation of its own. Mirowski highlights how writing in *American Anthropologist* in 1943, Leslie White[102] "proposed that all culture be conceptualized as a manifestation of "the amount of energy per capita per year harnessed and put to work," he continues, "This theme was taken up by many other anthropologists, such as [Leslie White's student, Richard Newbold] Adams." While their frame of analysis remained at the macro level, Leslie White and Richard N. Adams are commonly perceived as the first scholars to make energy a matter of concern in anthropology.

[103] Berndt, Ernst R. 1983. "From technocracy to net energy analysis: engineers, economists, and recurring energy theories of value." in *Progress in Natural Resource Economics*. Scott, A., editor. Clarendon: Oxford. pp. 337–366.

[104] Daly, Herman, and Alvaro Umaña. 1981. *Energy, Economics and the Environment.* Boulder: Westview, p. 167

bringing together "biology, physics and economics into a single science." Yet Mirowski states that these theories merely underline the simile between human labor and energy, and do not amount to a serious synthesis of the three disciplines. At the same time, these understandings of value seemingly dismiss the various ways in which value becomes generated through the sociality of exchange, as explored through a rich literature in anthropology.

Scholarship in the anthropology of value examines the economy by studying the social transformations that take place within spheres of exchange. In doing so, many scholars argue, monetary exchange is shaped and defined by varying beliefs, affects and cultural practices. Viviana Zelizer,[105] for instance, developing the notion of special monies, points to how the same amount of money may have a different meaning depending on how it is earned or what it will be used for. Similarly, Maurice Bloch and Jonathan Parry[106] emphasize how worldviews of a particular era give "rise to particular ways of representing money." Alternative currencies, as examined by Bill Maurer[107] for instance, may thereby be seen as symptomatic of the social conditions of a period. Taking Bloch and Parry's suggestion into account, what exactly were the motivations behind the formation of energy as a currency in these different eras?

Similar to "ergs," the ergos experiment embodied the commitment to a

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[105] Zelizer, Viviana A. Rotman. 1994. *The social meaning of money*. New York: Basic Books.
[106] Parry, Jonathan P., and Maurice Bloch. 1989. *Money and the morality of exchange*. Cambridge [England]: Cambridge University Press, p. 19
[107] Maurer, Bill. 2005. *Mutual life, limited: Islamic banking, alternative currencies, lateral reason*. Princeton, N.J.: Princeton University Press, or Chipchase, Jan, Panthea Lee, and Bill Maurer. 2011. "Mobile Money: Afghanistan". *Innovations: Technology, Governance, Globalization*. 6 (2): 13-33.

technoscientific infrastructure that would govern energy consumption at a time of uncertainty regarding future energy resources and regarding the future of economic systems. Perhaps it was hoped that an energy currency would resolve both problems at once with a single systemic transformation.[108] And yet, while "ergs" were long debated but never taken seriously by the American public, there seemed to be strong incentives to build and test ergos within the context of Masdar City.

For now, the researchers had to invest their time and thinking in the technical systems required for the successful functioning of an energy currency system, before they could assess whether their project was actually the institution of what Alexander fittingly called "a technocratic dictatorship."

**The Building Management System**

Before anyone could partake in the constitution of this imagined currency, specific technical facilities had to be installed within the buildings of Masdar City. Faculty, students and post-doctoral researchers from Masdar Institute thereby met with representatives from Schneider Electric, along with energy efficiency engineers

[108] Ergos is not the only energy currency proposal that has been put together in the early 21st century. DeKos, for instance, understood, as "a method for securing a more stable value currency via the central bank portfolio using electricity delivery assets," is also an attempt at fixing financial problems and energy problems at once. For more information on DeKos, please see: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1802166 Last accessed March 17, 2012 Also, in 1999, Richard Douthwaite, a philosopher and economist, came up with "ebcu," meaning environment-backed currency unit, which would enable one to buy goods from other countries in addition to the right to produce carbon dioxide. For more information, on ebcu, see Douthwaite, R. J. 1999. *The ecology of money*. Totnes, Devon, [Eng.]: Green Books. The theme of the International Social Transformation Conference in July 2012, where researchers from Masdar will also present their work, is set as "Energy Currency." For more information on the conference, see: http://teslaconference.com/ Last accessed April 2, 2012

from Masdar City to discuss how and when the Building Management System (BMS), what Rowan Moore, an architecture critic at *The Observer*, referred to as the "hidden brain" of the Masdar Institute building, would be completed.[109]

Building Management Systems are common technological infrastructures that have been implemented in large buildings since the late 1960s, mostly to control the building's indoor environment. Due to the decreasing price of hardware required for their manufacturing, these systems became further popularized during the 1970s. In addition to managing the building's environment by keeping track of heating, lighting, ventilation, air conditioning systems, or window opening and shading, such systems administer security, fire protection, lift operations, and surveillance mechanisms. Experts on building automation also stress that the historical development of building management systems is interlaced with improvements in technologies of computation, wherein the incorporation of computers, on top of various optimization techniques, provides opportunities to further complicate the machineries of control within large buildings today.[110] Given how the building machinery seeks to remain outside the conscious awareness of its residents, while having a decisive effect on how they live,

[109] Rowan Moore wrote, "There is something spooky in the controls [Masdar] employs in the name of the environment – a touch of eco-Orwell or at least eco-Huxley. A hidden brain, for example, knows when you enter your building, so that your flat can be cooled before you arrive, while in public places flat screens broadcast uplifting news on the environmental performance of the complex." See: http://www.guardian.co.uk/artanddesign/2010/dec/19/norman-foster-masdar-city-review Last accessed December 21, 2011. While on-site architects suggested that what they called "the intelligent system" would eventually enable such controls to be implemented, specifying that "when you're entering the building the entrance recognizes you and you walk into a room that's 24 degrees Celsius, and when you're out it goes up to 28 again," the system had not yet been put into use when my fieldwork ended at the end of May 2011.
[110] See, for instance: Wang, Shengwei. 2010. *Intelligent buildings and building automation*. London: Spon Press.

perhaps the analogy of the "hidden brain" is not so misplaced.

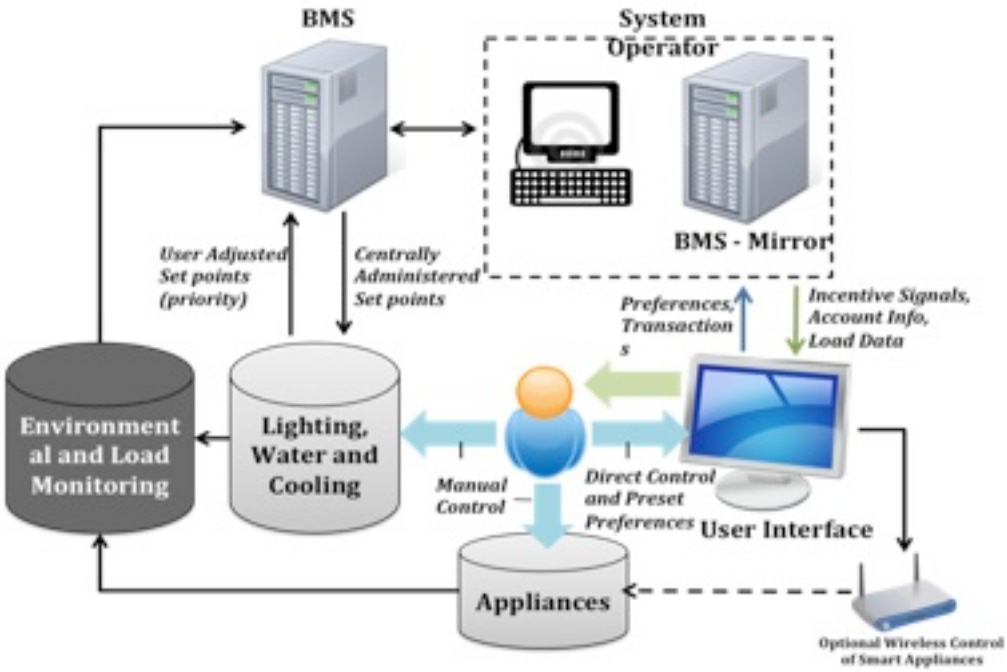


Figure 9 The expected workings of Masdar's intended BMS

At Masdar, however, the intended BMS was still not functional, and could not yet "know when you enter your building, so that your flat can be cooled before you arrive," as publicized in the article by Rowan Moore. During the meetings on the implementation of building automation system, Schneider Electric engineers initially explained that there was a half-working BMS in the Masdar Institute building, which had to be fine-tuned and improved so that they could manage to form a database by using the "raw values" that it fabricated. Here, raw values referred to the values that "the building produced without any intervention on the energy consumption of its residents." For the raw values to be made available, the Masdar Institute building

needed either an Intelligent BMS, referred to as I-BMS, which included web services and infinite access to database, or an Extended BMS, referred to as E-BMS, that still provided minimum access to databases, but no web services. The E-BMS would allow the Masdar team to actually collect data on energy consumption, though not to the extent that was imagined or expected. During a meeting held in October of 2010, Schneider Electric engineers concluded that they needed time for the whole system to begin working, at least another month.

The implementation of the desired BMS machinery would breathe life into the Masdar Institute building, augmenting its capacities of automation and control. It would not only contribute to the centralization of decision-making power and facilitate the dominance of an optimization logic within the building environment, but also prohibit the occupants from interfering with the system as much as they would like to. Thus once the BMS was fully functional, the raw values that the database comprised would be values produced by the "building" and not by its occupants. Unless the occupants matched the profile determined by the BMS control panel, they would have to come to terms with the discomforts of the building environment. During a three-hour long interview at a café on the Masdar Institute campus, Brad, an executive from Masdar City, asked me, "Temperature and air-conditioning change your mood when you're in a building. But people have different senses of temperature. Would you like to inhabit a room that is 23, 24 or 26 degrees Celsius?"

Fittingly, the building's temperature had been a topic of heated debate on the

Masdar Institute campus. Some architects summed up the discussion as one occurring between the Emiratis and the non-Emiratis. According to them, the Emirati students had become used to occupying buildings that remained firmly set to 21 degrees Celsius, or even less. "Don't you freeze when you go to shopping malls in this country," one of the architects asked me, thereby problematizing temperature as a matter of cultural concern. However, stabilizing the temperature at the desired 21 degrees Celsius level would increase the Masdar Institute building's energy demands significantly. They knew that the temperature would be somewhere between 21 and 26 degrees, and after weeks of deliberations, another on-site architect explained, they had decided to settle on 24 degrees Celsius. The decision had made some of the occupants upset, they suggested, but was implemented anyway. One architect added that the compromise is between maximum flexibility and sustainability. "It's not possible to have both at the same time," he underlined.

The architects were not the only ones who pointed to the unavoidable tension between maximum flexibility and sustainability. Martyn Potter, the facilities manager of Masdar Institute, at times referred to as the "green policeman," also wanted to make sure that the theoretical notions of sustainability would not be compromised at Masdar City, though this would often require a surrendering of flexibility. According to him, this would be the future of energy management in the US and Europe as well.

An article in *TIME* magazine[111] suggested for instance:

> Martyn Potter, Masdar's director of operations and facilities, noted that most Abu Dhabi citizens are used to keeping their air-conditioning as low as 60°F (15.5°C) — it helps that electricity is heavily subsidized — but in Masdar, AC needs to be set closer to 77°F (25°C) to keep within its efficiency targets. With the ability to monitor exactly how much electricity every room in the city is using, Potter can keep citizens in line. "It's name and shame," he says. "I'm a green policeman."

Another article in the *Guardian*[112] added:

> Here, residents live with driverless electric cars, shaded streets cooled by a huge wind tower and a Big Brother-style "green policeman" monitoring their energy use…."The city is a laboratory for the future," says Martyn Potter, director of operations at the institute and dubbed the "green policeman". The Big Brother approach to cutting energy is likely to become the norm as computerised smart grids are rolled out in Europe and the US, he adds. "I want to know exactly how these buildings work. I can pinpoint who is using most energy and water, whether in an apartment or the academy. Certain students have been used to having the air conditioning on at 16°C (61°F), here it is 24°C. Yes, they complain. But I have told them that's how it is."

When I asked him what he thinks about these on-going complaints from the building residents, "But that's exactly why," Brad sipped his iced coffee, "We have to implement dummy controls." Laying out how dummy controls are used, he recapitulated, "You get up and change the environment psychologically. And that saves so much energy." In the earlier months of my fieldwork, I had become familiarized with dummy controls during an interview with Kareem, a young energy efficiency engineer from Masdar City. He had convincingly stated that building

[111] http://www.time.com/time/health/article/0,8599,2043934,00.html#ixzz1pGg0Z1Dg Last accessed March 16, 2012

[112] http://www.guardian.co.uk/environment/2011/apr/26/masdar-city-desert-future Last accessed March 16, 2012

occupants were more satisfied with their living situations when they believed that they could change temperatures, even if they were not really doing it. He had superficially referred to a study in China, wherein engineers had implemented dummy thermostats in rooms in response to repeated protests by the residents of the office block regarding their lack of control. "The dummy thermostats made everyone much happier," Kareem reported. In the industry, this placebo effect was argued to provide illusion of control to tenants, without compromising on the system's efficiency.

At Masdar Institute, the "hidden brain" of the building would serve as a discrete sense-making apparatus. In her book on the emergence of the sick building syndrome, Michelle Murphy[113] touches upon such sense-making capacities, and proposes the concept "regimes of perceptibility" to describe the ways in which certain phenomenological conditions become blocked, while others accentuated, thus creating a definitive methodology for the building occupant to relate to his or her environment. In the China example proposed by Kareem, the dummy thermostats had served as material manifestations of the desired "regime of perceptibility" within the building environment. If they were implemented in the Masdar Institute building, the subjects who privileged sight over thermoception would easily be manipulated to believe that their environment had been improved, when the thermostat remained fixed at the temperature that they determined. The ability to determine temperature

[113] Murphy, Michelle. 2006. *Sick building syndrome and the problem of uncertainty: environmental politics, technoscience, and women workers.* Durham: Duke University Press

would equip them with the capacity to prove their mastery of the building machinery, while the building machinery worked in what one may call a deceptive manner, forever debilitating the occupants' capacities to steer its directions.

Yet Brad did not think that this would necessarily constitute a troubling development. The individuals inhabiting the building would be led to consume less energy, and therefore contribute to a higher good. They would be doing this rather unknowingly, but Brad argued, this could well be beside the point. As such, dummy thermostats, and the imperceptibility produced through them, seemed like an ideal scenario for the time being, until consumers became more aware of the urgency of energy conservation and efficiency. Brad did not talk about how building occupants would become more aware of their consumption, if they were consistently manipulated by a technological infrastructure. In some sense, the dummy thermostats would prevent the inhabitants from taking responsibility regarding their habits, continually dependent on the technologies of the building, rather than motivate them to become more conscious of their energy consumption.

"But tech-cities may begin to use even more resources, and in this way Masdar could be part of the paradox," Brad then pointed out. "This place looks like Star Trek, but maybe ecological places must be low-tech, passive houses. Here we go high-tech and we pay for efficiency, but that may not work either," he added. The possible realization that Masdar could constitute a paradox, as provocative as it may be, did not necessarily mean that the people at Masdar City should suddenly stop what they

were doing. Everyday discussions and practices, which constituted the building blocks of this tech-city, consumed the individuals working within Masdar City, and allowed them to live with the paradoxes that they passingly identified.

Yet for now, an energy efficiency engineer confirmed, there were no thermostats within the rooms at Masdar Institute. A meeting on BMS implementation, which took place in a meeting room inside the makeshift offices of Masdar City, continued with how the absence of thermostats prevented the building residents from tinkering with central environmental conditions, dictated by the half-working BMS. Two Masdar Institute students, who attended the meeting as research assistants, shyly provided some feedback to the remaining nine participants, underlining that despite their beautiful design, the rooms were mostly cold, and uncomfortable. The students' complaints were noted down. The building would soon be improved, the energy efficiency engineers working with Masdar City and with Schneider Electric promised.

"You guys are learning how to use controls – we need a booklet on how all systems work, it's weird that you never get a how to use book for buildings," Daniel, an on-site architect, announced during an on-campus presentation to the Masdar students. "The BMS system is not functioning properly," he said, "and BMS runs this building like a ship, and when you don't maintain the BMS system then you can't run the ship properly. Imagine the BMS as the management unit of the ship," he emphasized. The ship, a life-supporting environment amidst an ocean where human

life is continually in danger, was put at risk due to the malfunctioning of the BMS, but would soon be improved with students' cooperation.

Daniel noted how unlikely it is for any architecture office to work together with the same client for such a long time. Now, they could receive feedback from the students, and design the next phases accordingly. They wanted to organize a stakeholder group, wherein they would sit with the students and learn from their experiences of living in the Masdar Institute building. This type of conversation would improve the architects' understanding of the context where they worked, while allowing them to better formulate possible problems and opportunities in upcoming projects of a similar scale. For instance, having this stakeholder group at Masdar Institute could help improve conceptual design and planning for the upcoming Apple City in Cupertino, California, recently commissioned to Foster + Partners, the architecture firm operating within Masdar. The students, here serving as subjects of the building experiment, could help the architects develop their work in productive ways.

While remodeling climatic conditions within Masdar Institute rooms, the energy efficiency engineers wanted to test new green appliances as well – washing machines, dishwashers and stoves – that had been supplied by General Electric (GE). The appliances had been sitting in storage for some time, but one Masdar employee insisted that it was time they were installed. During an informal conversation at a trade show, a GE representative had told me that in the future everything would be

"smart and regulated, just as they were at Masdar City." (chapter 1) According to this employee, GE was "enabling this future by producing smart kitchen appliances." Moreover, they were active in other parts of the green economy, not only producing smart grids, but also making sure that the fossil fuel economy becomes cleaner. Yet some weeks later, when we ran into each other on the Masdar Institute campus, Farhad, an engineer working with the energy efficiency unit at Masdar City, suggested that the appliances had required an investment in pots and pans too, because they utilized a specific induction technology that prevented common pots and pans from being heated. He complained about how expensive the new pots and pans had been, and added that they would, for the time being, limit the use of green kitchen appliances to a few double rooms in the residences. There is never any end to this, he laughed. The material properties of this technology signaled an excessiveness, which set in motion new pathways that could not be contained within the technology itself, and which seemingly cast a shadow on the ideas of conservation or sustainability.

The BMS meetings, which continued during the months that I conducted research in Abu Dhabi, often transformed into post-meeting discussions on how the third party contractors were not working properly. The workers were underpaid and not well trained, the material used was not chosen correctly, or did not reflect the priorities of the subcontractors. These types of inconveniences were argued to be causing delays in the implementation of the BMS in the Masdar Institute buildings. Talal, a Schneider Electric representative who oversaw the implementation of the

BMS, reiterated this point during an interview, suggesting that although the problems with the system were not entirely their fault, it was likely that Schneider Electric would not be the subcontractor for the next phase of construction. The company was still committed to Masdar City, Talal confirmed, soon they would be building their innovation center within its boundaries, along with other companies such as Siemens, Bayer and BASF.

When I asked a post-doctoral researcher how she felt about the meetings, she described them as a "disaster." She could easily spot the conflicts that different systems had with each other. "For instance, when they purchased smart meters from LG to measure electricity consumption in the student residences," she told me, "they did not cooperate with Schneider Electric, so although all the technical instruments were available, in February or March of 2011, water or electricity consumption in the building was still not being monitored." She proposed that one way in which this could have been dealt with would be to have Masdar take over responsibility for third party contractors. Then they could manage the whole system in a way that is tightly connected, and eliminate frictions between different systems, she concluded. In some ways, what she implied was that Masdar should have been treated as a total infrastructure wherein multiple layers of function and meaning would be integrated seamlessly, making it difficult to identify the points in which they came together. Instead, what she observed during the meetings was the opposite of such seamless integration. Rather, she found herself having to constantly watch parties negotiate on

why and how things did not work, while trying to find quick solutions. She suggested that if this had been a total infrastructure, then problems would rarely emerge, and when they did emerge, they would be resolved by a single overseer, in this case Masdar.

Yet I argue that these inconveniences were instrumental in pushing researchers and professionals working with Masdar to concentrate on short-term problems and solutions, thereby giving them the capacity to leave aside the larger questions regarding their work. Therefore, I suggest that the tensions between different technical layers, which caused delays in implementing the BMS, were critical in pushing the project forward, and in increasing the level of anticipation for its imminent launch. The potential paradoxes of the project, passingly acknowledged, then became secondary to minute material victories. The idea of serving a higher good by helping humanity in its quest for energy also enabled the project to continue on a steady course. On the other hand, the multiple steps associated with building ergos produced Masdar Institute students as subjects within an experiment, consistently tested on regarding issues ranging from building design to climatic conditions.

**The Demand and Response Study**

"Once the BMS is up and running, we can start the research project," one of

the faculty members associated with the ergos project, reported during a preparatory meeting for the Demand and Response Study. I was responsible for preparing a survey that would be conducted amongst the students at Masdar, and that would be repeated several times during the course of the experiment. We would thus measure students' financial and ecological sensitivities not only to better structure the study, but also to see how students' sensitivities transform during the period in which the study was being conducted. Another faculty member at the Institute handed me a sheet of ecological and financial sensitivity indicators, to be incorporated within the survey design.

| | Strongly Agree | | | | Strongly Disagree | Don't know |
|---|---|---|---|---|---|---|
| **Example: Most lakes in the world are polluted.** | 1 | (2) | 3 | 4 | 5 | 9 |
| Claims that we are changing the climate are exaggerated. | 1 | 2 | 3 | 4 | 5 | 9 |
| Over the next several decades, thousands of species of plants and animals will become extinct. | 1 | 2 | 3 | 4 | 5 | 9 |
| Modern development threatens wildlife. | 1 | 2 | 3 | 4 | 5 | 9 |
| While some local plants and animals may have been harmed by environmental degradation, over the whole earth there has been little effect. | 1 | 2 | 3 | 4 | 5 | 9 |
| Environmental protection is beneficial to my health. | 1 | 2 | 3 | 4 | 5 | 9 |
| A clean environment provides me with better opportunities for recreation. | 1 | 2 | 3 | 4 | 5 | 9 |
| Protecting the environment will threaten jobs for people like me. | 1 | 2 | 3 | 4 | 5 | 9 |
| Laws to protect the environment limit my choices and personal freedom. | 1 | 2 | 3 | 4 | 5 | 9 |
| The effects of pollution on public health are worse than we realize. | 1 | 2 | 3 | 4 | 5 | 9 |
| Environmental protection will help people have a better quality of life. | 1 | 2 | 3 | 4 | 5 | 9 |
| Pollution generated here harms people all over the earth. | 1 | 2 | 3 | 4 | 5 | 9 |
| Environmental protection benefits everyone. | 1 | 2 | 3 | 4 | 5 | 9 |
| We don't need to worry much about the environment because future generations will be better able to deal with these problems than we are now.* | 1 | 2 | 3 | 4 | 5 | 9 |
| We are approaching the limit of the number of people the earth can support. | 1 | 2 | 3 | 4 | 5 | 9 |
| Humans have the right to modify the natural environment to suit their needs. | 1 | 2 | 3 | 4 | 5 | 9 |
| When humans interfere with nature it often produces disastrous consequences | 1 | 2 | 3 | 4 | 5 | 9 |

Figure 10 Examples of Environmental Sensitivity Indicators

Going over these indicators, I felt tempted to add more of my research questions, or to slightly change the wording in some of them. I wrote, "I believe technological advances will resolve environmental problems," wondering how the student body would respond. I included "I feel bad when I don't recycle glass bottles," reflecting on my own relationship with garbage. Slowly, the survey's original intentions of depicting the ways financial and environmental sensitivities come together, were being marginalized, making it challenging for me to relate to the knowledge produced within the framework of the Demand and Response Study while remaining attentive to my own research. In some sense, I tried to produce ethnographic data through the survey, and in fitting my questions within, I realized that the former indicators slowly became muffled. I overnighted to prepare a first draft, knowing that what I was producing was not going to be exactly successful. In the meantime, I read up on survey methodologies and the production of ecological or financial indicators. I reminded myself that I had prepared surveys for many courses during my undergraduate studies, yet still felt unaccustomed to the circulating vocabulary. Like the other researchers working on the experiment, I lost sense the end goals of this survey. The tensions between the two systems of knowledge – on the one hand the quantitative data I was expected to produce through accurate survey design, which would enable me to depict where each student fell within a graph of financial and ecological sensitivity indicators, and on the other hand the ethnographic

data I wished to acquire regarding the students' relationship to Masdar and or to eco-friendly infrastructures – which I had to overcome during the preparation of the survey, made it easier for me to concentrate on the everyday challenges of my work. I postponed a more meditative thinking to a later time.

During this period, I also met regularly with Prasad, another post-doctoral researcher at Masdar Institute, to learn more about electricity consumption and pricing. Initially, he outlined the existing means of electricity pricing in the Abu Dhabi markets, as well as markets elsewhere, and highlighted the advantages of dynamic pricing. But the Demand and Response study would take dynamic pricing, a time-based pricing technique where electricity generators have different rates for electricity at different times of the day, a step further by learning more about the incentives that shape consumption patterns. Prasad explained that they had devised the study with the intention of assessing the impact of different incentive schemes on the energy usage of the participants; intending to alter the timing, level of demand, or total electricity consumption through financial or social rewards.

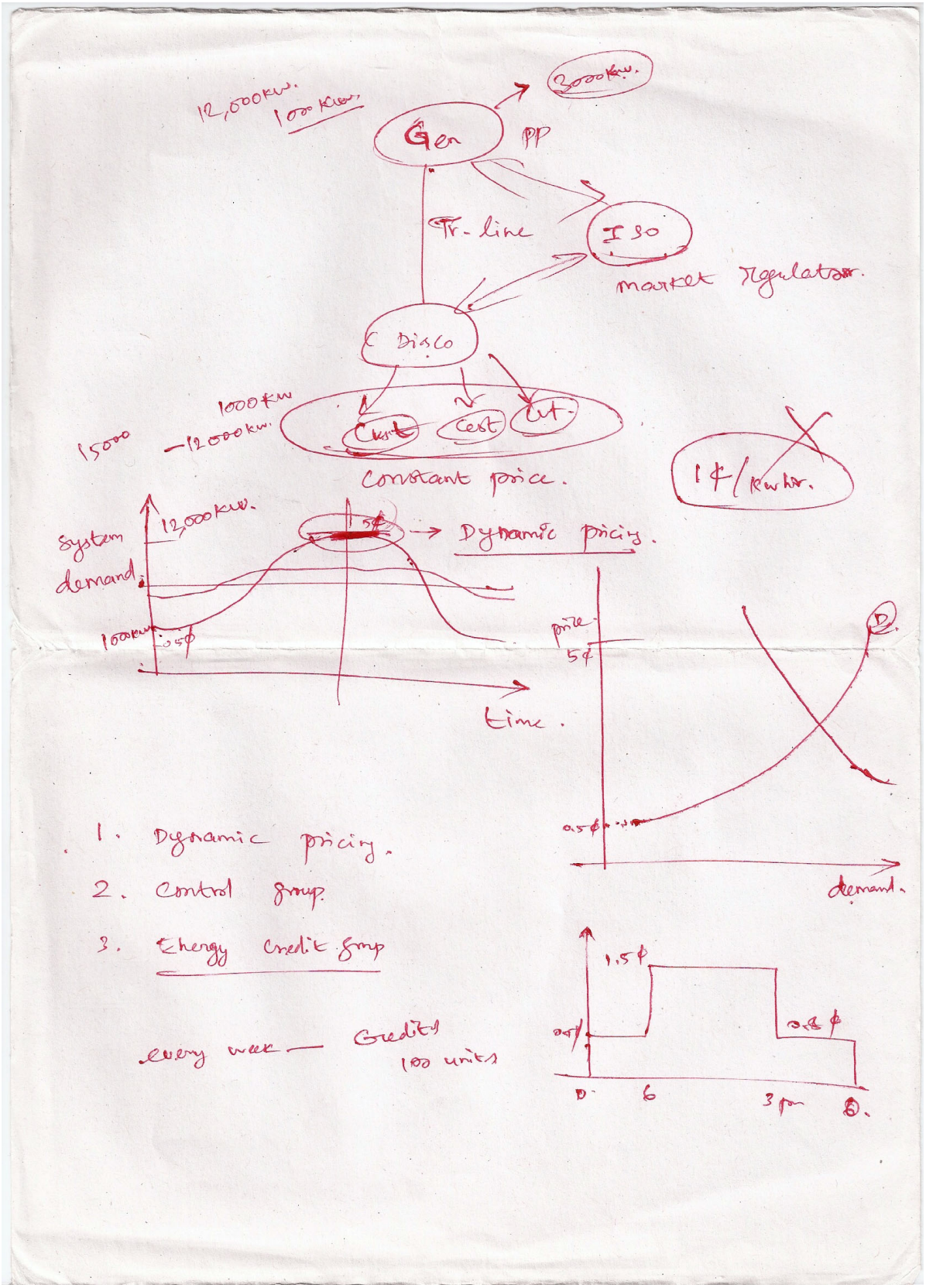


Figure 11 Prasad's Sketch of Electricity Markets

In order to conduct this test they had to separate the students, who would act as surrogates of a larger group of future Masdar City residents, into four groups:

(1) The first group, called "Real-time Pricing," would receive hourly signals that charted the price for consumption over the following hour. The researchers would add in price spikes and more volatility to the market, to adequately see how consumers respond to real-time pricing of energy.

(2) The second group, "Energy Credits," would be issued a balance of energy credits over a limited period. If the users did not spend all their credits, at the end of the limited period they would be able to sell them at a market managed by research administrators.

(3) The "Flat-rate Comparative" group on the other hand only relied on information about the energy consumption of their neighbors in making decisions, possibly shifting consumption habits after seeing how well or how badly she or he ranks amongst peers.

(4) Participants to the "Flat-rate Control" group received no information at all, and were able to freely adjust consumption.

The experiment would continue for a year, demanding the participation of all the Masdar students who were residing in the building.[114] In August 2011, when the

[114] The experiment could not be started during the year I spent in Abu Dhabi. The researchers argued that they had to receive a new batch of students, apply the survey, and then monitor their consumption during the following year. It would make more sense for the project to start in September 2011, so that they could follow the same consumers as they lived in the building for one or two years.

Demand and Response Study was finally publicized, the English language UAE newspaper *The National* wrote:[115]

> When this year's batch of new students at Masdar Institute signed up for their courses, they expected they would be there to learn and conduct research. They might not, however, have suspected that they would be the subjects of a Big Brother-style social experiment. Other researchers will be watching them closely; not for their personal interactions and flirtations, as in the popular television show, but something much simpler — their bills. They will be the subjects of a year-long investigation into which incentives encourage people to use less energy and water.

The ecology blog Green Prophet, which closely follows developments at Masdar City, most often enthusiastic and supportive regarding the developments within the compound, agreed with the Big-Brother comment, and explained:[116]

> Masdar City in Abu Dhabi is aiming for carbon neutrality in an unforgivingly hot and dry environment teeming with young students. Naturally these twenty-somethings – among the world's brightest – will strive to achieve the maximum amount of comfort in their spaceship home away from home even as they are participating in one of the most expensive carbon-less experiments on the planet. But now they are being watched! In an effort to understand what incentives and stimuli drive students to switch their lights and taps on or off, Masdar will track their energy and water consumption over the next year.

While the articles both acknowledged that there was a Big-Brother side to the experiment, they also showcased how significant it was for energy consumption to be monitored. By pinpointing the kinds of incentives that actually work among the

[115] http://www.thenational.ae/news/uae-news/technology/masdar-students-energy-and-water-use-monitored Last accessed December 17, 2011

[116] http://www.greenprophet.com/2011/08/masdar-students-energy-water/ Last accessed December 17, 2011

existing student body, researchers and professionals could develop tools for encouraging energy-efficient consumption behavior in the future. They suggested that if the experiment was successfully implemented, the information from the study "could be widely distributed to help other countries develop proven programs that support energy and water conservation!" Again, while the social set up required for the information to be gained was somewhat criticized, the end goal of the experiment seemed to point to a higher good, which would benefit humanity as a whole in battling energy problems.

During my conversations with Prasad, I wondered how the students would react to living with these emergent systems for a whole year. Yet even before the experiment was publicized, the students at Masdar Institute frequently admitted that their daily life was constituted as an experiment. For instance, Laura, who was amongst the first students to settle in the Masdar Institute building, wrote in her blog:[117]

> I keep telling people that it feels like I'm living in a psychology experiment. Every time I flip a light switch in the living room and the faucet in the bathroom starts running, or I desperately push all buttons on the stove to try to turn on a burner, I can't help looking over my shoulder and wondering if there's a scientist observing my behavior and reactions in this strange environment. Especially when I go around pressing all the walls to see if there are more secret doors, or I stare up in bewilderment at the kitchen cabinet shelves that are so tall and far off the ground that I doubt the tallest human on earth could use them effectively. Or the time I was working in the lab, a short alarm went off

[117] http://squidskin.blogspot.com/2010/09/i-live-in-spaceship-in-middle-of-desert.html Last accessed December 17, 2011

> on the loudspeakers, and a male voice said something official-sounding in Arabic with a French accent.

Laura was not the only one who suggested that she felt like being in an experiment all the time. Sally, who was Laura's classmate, also suggested that she felt like a subject in an experiment, but was rarely acknowledged for it. She argued that this feeling was related to being part of an institution that was just being set up, and that did not really have a strong working infrastructure. The students were encouraged to partake in the making of this new system, in some sense co-producing Abu Dhabi's sustainability measures, but Sally did not know if the administration truly cared about their reactions. Another student from the same class put forth that at Masdar they were being experimented on what happens when technology dictates actions. What kind of a prototype is Masdar City, he asked, that must be what they're trying to test.

I agreed with the students that Masdar was a testing ground of new technologies. At the same time, these new technologies were also there to manufacture new subjectivities for the inhabitants of Masdar, altering their habits and conceptions of energy use. "If all problems were technical, we would have solved them a long time ago," Nawal, the sustainability director of Masdar buttressed during a panel on new cities at the Harvard Graduate School of Design in April of 2010. "Problems are cultural. Teaching people sustainability is like teaching them table manners." In some sense, teaching sustainability appeared to be Dr. Nawal's "civilizing mission."

Dr. Nawal, as she was referred to by many of her colleagues, had obtained a PhD from Newcastle University in 2002, and written her dissertation on prison buildings in Abu Dhabi. Prior to joining Masdar City, she had served as the director of the Abu Dhabi police, where she also had the opportunity to publish academic articles on prisons and sustainability in hot and humid climates. Her team of sustainability experts had dwindled due to budgetary cuts during the two years in which I knew her (between June 2009 and June 2011), her responsibilities had changed, yet she remained resolute on sustainability practices. Thus she ran a project to prevent Masdar employees from using plastic bottles and manufactured reusable bottles for them, she asked that the garbage bins be removed from the cubicles thereby forcing employees to walk to the recycling bins, and she managed the START campaign[118] with the goal of raising awareness regarding the significance of personal habits of consumption. In this process, the employees were asked to sign a "sustainability pledge" thereby proving their commitment to a more sustainable lifestyle.[119] In private conversations, however, the employees suggested that they were not happy with the new measures implemented within their workspaces and demanded free choice. Dr. Nawal's team, on the other hand, thought that the employees would get used to this new system. It would only take some time for them

[118] For more information on the START campaign, please see: http://www.masdar.ae/en/MediaArticle/NewsDescription.aspx?News_ID=155&News_Type=PR&MenuID=0&CatID=64 Last accessed December 22, 2011

[119] For more information, please see: http://www.tradearabia.com/news/env_191145.html Last accessed December 22, 2011

to adapt to the promoted sustainability mechanisms.

On the other hand, for the student body, the Demand and Response study became grouped together with a series of experiments, and somehow lost its specificities. What mattered more to the students was that this was an experiment on how technology dictates behavior, just like many others that they had to experience during their time at Masdar. For them, Masdar City as a whole had become an experiment, which undoubtedly produced the students as experimented subjects. While arguing for the abstraction of a better world with more attention on energy production and consumption, the experiments neglected the immediate social conditions that they produced. The students, along with Masdar employees, were expected to unlearn certain social habits during the time they spent within Masdar City, and take on new sustainable ones.

**(Re-)Defining Masdar City**

So what kind of prototype was Masdar City? I agreed with the students that the experiment was being constantly redefined and renegotiated. The marketing department had come up with a promotional statement at the very beginning of the project, suggesting that Masdar would be the first zero-carbon city of the world. But what did zero-carbon mean?

For Dr. Nawal, the director of Masdar's sustainability team, the key to being

"zero-carbon" was the integration of sustainability to all phases of the city's production. "We have narrow streets, natural shading, high-density living, public spaces, mixed-use areas, and a good transportation system," she listed. But during the question and answer session at the new cities panel at Harvard Graduate School of Design, someone from the audience asked her how Masdar's basic needs would be supplied. "How will Masdar City be zero-carbon if you don't produce food on site," the audience member inquired. Dr. Nawal answered that they would try to produce food on site too, but her answer did not prove to be too satisfying.

But it wasn't only outsiders that challenged the meaning of zero-carbon. Students in the Institute, as well as employees in the other departments of Masdar spoke about the zero-carbon qualities of the city in joking terms. An architect, who had worked with Dr. Nawal in the sustainability department of Masdar, explained to me how she had lost faith in the future of the project. "Let's call it a clean tech cluster," she suggested, "that would take so much weight off our shoulders." According to this explanation, reframing or redefining the project would resolve its problems by decreasing everyone's expectations.

Still, researchers in the Institute strived to set out potential plans to make Masdar City "zero carbon." Alexander thought that ergos, the new energy currency, would be critical in establishing Masdar as a zero-carbon city. According to him, there were three ways in which an eco-city's carbon emissions could be defined. First there were "strictly zero carbon" cities, which did not emit any carbon to begin with.

Second were "net zero carbon" cities, where carbon emissions could be eliminated or balanced. Third, a city could be "carbon neutral." In this case, the residents of the city would be required to purchase third-party carbon offsets to balance their carbon emissions. "Of course, we've dropped even these…" he said in frustration, pointing to how Masdar City's claims to be a zero-carbon city had slowly faded away. Many in the audience shared this at times public discontent regarding what they conceived to be the foundering ideals of Masdar City, and grinned at each other.

Later Alexander went on to classify different types of carbon emissions. "Internal emissions" were emissions produced within the boundaries of a city, by the city residents. "External emissions," on the other hand, were emissions produced through the goods that come into the city. "Out of scope emissions" would constitute items such as private employees commuting, so they were caused by the residents of the city, but not within the city itself. After this brief overview, he asked: "Can Masdar City be zero-carbon?" He responded to his own question with a determined yes, and suggested that it would only come at some cost. "We must keep in mind that our world is running out of fossil fuels – besides there is climate change," he conclusively stated.

When defining Masdar City as well, the formal definitions of different types of cities and of different carbon emissions and higher ideals became combined to produce incentives to proceed with the project. The paradoxes of the city, in this case brought up by an audience member during a panel at Harvard, and by others from

inside the project, were not directly confronted, thereby further underlining the tendency to remain inattentive to the potential bigger picture problems. What role would ergos play in creating the zero-carbon city that was once envisioned? The researchers and the professionals working on the study remained keen on underlining how ergos was key to creating awareness regarding sustainability. However, the steps required for creating ergos triggered side effects that could be avoided for the time being, but that in the end would transform social, political and economic relations within communities drastically.

Yet how exactly did Alexander and his colleagues make decisions to further commit to technological infrastructures in promoting energy efficiency, when they feared a possible technocratic dictatorship? First, I argue that the small rather mundane steps towards the constitution of the project enabled Alexander and his team to leave these bigger ideas aside, while simultaneously making them more and more ingrained in the discourses and practices required for reaching the final goal. At the same time, the researchers remained convinced that the project would serve an abstract higher good, eventually helping humanity in dealing with energy problems. Having fully grasped the potential risks they unleashed, the researchers seemed confident that technology could be used as an educational mechanism, whereby inhabitants of Masdar would learn more about their consumption behavior. They hoped and believed that an energy currency could allow people to make informed yet free choices. Simultaneously, they thought of their project as a somewhat

revolutionary proposal, which would change the understanding of money and energy completely. In addition to the everyday discussions and practices associated with the realization of the project, this belief allowed the researchers to disregard the fears associated with a somewhat dystopian future.

As of April of 2012, the experiment had still not started, due to repeating everyday problems, mostly associated with the BMS. "The showers and the air conditioning, even those problems still haven't been resolved," a research collaborator that I spoke with told me, "they cannot seem to find what is wrong with the building, or resolve it." Ergos, consistently postponed due to the many interlinked inconveniences, thus became a fantasy object for the researchers and professionals at Masdar.

In the next chapter, I will explore another emergent artifact at Masdar, which also suffered from various operations related problems, but which nevertheless became categorized as a success, at least by some.

## CHAPTER FOUR:

## DEFINING FAILURE: PERSONAL RAPID TRANSIT SYSTEM

### Failure

"The Market @ Masdar City," defined as a family-focused street fair and organic market, took place on April 29th 2011 on the Masdar Institute campus, and promised to "offer Abu Dhabi residents a glimpse at life in one of the world's most sustainable, urban developments." It was the first time in which the residents of Abu Dhabi were openly invited to visit the campus, attempting to establish it as a public space within the Emirate. In addition to the organic grocery store, the sushi restaurant and the coffee shop, retail spaces located permanently on site, about thirty exhibitors, such as RIPE Market, Solace Organics, the Organic Foods and Café, @Home, Ekotribe, the Philippine Community Fund, The Little Fair Trade Shop, K's Cookies, Baby Cakes, Hessa Al Mazrouei T-shirt, and Foa Flowers, would be displaying or selling their products to the visitors. A few minutes after arriving at the campus, I ran into Jeff, one of the on-site architects, right outside the sushi restaurant, as he studied the visitors wandering in the Masdar Institute building's courtyard, taking occasional photographs. "When you build it, people come!" he proudly greeted me, underlining how crowded the building was with visitors, already at midday. I asked Jeff, "Have you seen the long line outside the PRT?"

One artifact that made the construction site of Masdar City unique and attractive to visitors was the driverless electric personal rapid transit (PRT) pods that offered personal on-demand non-stop transportation between any two points on a network, arguably combining the advantages of cars (private travel at any time) and public transport (no congestion and parking issues). The PRT had been envisioned to connect the entire eco-city through a 38-kilometer network, accommodating 1,800 vehicles at about 87 stations for passengers while also stopping at about 120 freight points, thereby allowing for the widespread distribution of goods. This expansive transportation network would be located at the basement level of the eco-city, commonly referred to as the undercroft, thus preventing the pod cars from disrupting the everyday life of the Masdar City streets. This meant that the whole city would have to be raised one level, about six to seven meters above the ground. While initially a plausible scenario, the project as a whole proved to be financially demanding, leading Masdar executives to drop the plans for the PRT completely, and go on a search for alternative emission free means of transportation for the eco-city, such as electric buses or cars. And yet, there remained one destination that passengers at Masdar Institute could travel to – the parking lot outside the building.[120]

[120] The existing PRT system between the Masdar Institute building and the parking lot was comprised of 10 passenger and 3 freight pods, which were stationed at 2 passenger and 3 freight stations connected by approximately a one-mile track. The system remained in operation 18 hours a day, seven days a week serving the Masdar Institute students, faculty and visitors. Trips between the parking lot and the Masdar Institute building took about 2.5 minutes, and were free of charge.

Figure 12 The PRT Pod Cars at Masdar Institute

In his book *Aramis, or the Love of Technology*, Bruno Latour[121] studies the implementation of a similar PRT network in Paris, and conducts what he calls an "autopsy of failure," mainly by analyzing documentary evidence and interviewing the foremost actors involved in the production of the network. He shows how, in implementing a "nominal Aramis," the actors failed to rework the project in conjunction with existing social and material demands of the city. He concludes that the failure of the research project was not any particular actor's fault, but that the technology could not be re-negotiated and re-adapted to changing social and material circumstances. In this account, the definition of failure thereby remains uncontested.

[121] Latour, Bruno. 1996. *Aramis, or the Love of Technology.* Cambridge, MA: Harvard University Press.

My goal in this chapter is ethnographically similar, as I try to explore the implementation of a PRT network in Masdar City. Yet unlike Latour's account of Aramis, which starts off with an admission of failure, I contend that "failure" did not have an explicit definition within the PRT network of Masdar City. What exactly did "failure" mean in this context? And what did it produce?

In this chapter, first, I try to show how the attempts at implementing a city scale emission free PRT system within Masdar City had rekindled the discussion around future transportation systems. While the plans had not materialized due to financial problems, they had enabled different actors to meet on the same conceptual plane, constituting an intellectual collectivity around the emergence and the cancellation of the PRT. In other words, Masdar City's investments in this technology had not delivered the desired efficient and flexible transportation network, but they nevertheless had productive results.

In the meantime, the short, rather symbolic, pilot PRT line between Masdar Institute and the parking lot outside had become a source of everyday conversations on campus, due to various technical complications. In further elaborating their frustrations with these mundane mishaps, the Masdar Institute community had mythologized the moments when the problems became unmanageable. The incident of the burning pod, an occasion that many had not experienced first hand, thus became a somewhat mythical tool for re-articulating the everyday frustrations, but also brought Masdar Institute students together.

Lastly, the pilot PRT line constituted an aesthetic pleasure for those who frequented the emerging eco-city, leading many students at Masdar Institute to call it an "expensive toy." A toy, as Walter Benjamin would argue, is at times an artifact that could have been intended for something else, in this case a flexible and efficient transportation system. However, Benjamin continues, through play and repetition, the child is capable of re-imagining the artifact as a toy. Through short back and forth rides in the PRT, the frequenters of Masdar City were able to do the same, thereby re-configuring the prototype as an "expensive toy." The shared habit of playing with the PRT had thus led to the constitution of a collectivity within Masdar City as well, a collectivity that shared the everyday experience of aesthetic enjoyment through this short back and forth ride. Could aesthetics constitute a shared domain in which sustainability ideals would be constructed? Or could sustainability then be about sharing a sense of beauty?[122]

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[122] All in all, what seemed like "failure" based on the stated purpose of the PRT in fact facilitated the emergence of a collectivity both around and inside Masdar City. Similar conceptions of emergent communities have been debated extensively in scholarly literature on technological failure. In discussing the clean-up operations after the partial meltdown of a nuclear reactor in France, called Saint-Laurent 1, for instance, Hecht argues that the clean-up was like a ritual, bringing the nuclear employees together. "[B]y the time the clean-up ended," she suggests, "they had reaffirmed their solidarity as nuclear employees." Her argument recalls the ritual analysis that Hugh Gusterson employs in understanding nuclear tests in Livermore Laboratories. In both of these cases what the "ritual" of clean-up or nuclear testing brings forth is solidarity amongst employees working with these particular nuclear technologies. In the case of Masdar, however, the shared experience of the PRT did not constitute a ritual for those enjoying it. While it did formulate a collectivity, the group of people who participated in discussions on the PRT, were not tied together in solidarity. In this sense, the collectivity produced here was perhaps more ephemeral, bound together by co-habituation of a conceptual and aesthetic plane regarding a specific technological infrastructure. Gusterson, Hugh. 1996. "Nuclear Weapons Testing: Scientific Experiment as Political Ritual." in Laura Nader, ed., *Naked Science: Anthropological Inquiry into Boundaries, Power, and Knowledge,* pp. 131-147. New York: Routledge. Hecht, Gabrielle, 1997. "Enacting Cultural Identity: Risk and Ritual in the French Nuclear Workplace," *Journal of Contemporary History,* 32(4): 482-507.

In the rest of this chapter, I will first discuss the development of an intellectual collectivity where ideas around future transportation systems were expressed. Next, I will detail the everyday workings of the PRT, and investigate mythmaking around this experimental artifact. Third, I will examine the emergence of an aesthetically led collectivity, amongst the people who enjoyed riding the PRT from the parking lot to the Masdar Institute building. Could the efficacy of this technology then be evaluated in different ways? Rather than studying its ability to perform in the planned manner, perhaps it would be useful to understand it as the "toy" that it became, and examine how its "toyness" was perhaps an accomplishment.

**The Imaginary of Automated Transit**

The PRT pods, which would be the primary means of transportation within Masdar City, had first been exhibited on the opening day of the World Future Energy Summit in Abu Dhabi in January 2009, giving the visitors a sense of the eco-city's futuristic ambitions.[123] The pods, designed by Zagato, an Italian design and engineering company famous for sleek racing cars, had been manufactured in the Netherlands by 2getthere. Some[124] argued that the PRT was the most innovative element of Masdar City, "representing a breakthrough in the transport world." The

[123] For some images of the exhibit see: http://www.flickr.com/photos/imresolt/3209978452/in/photostream/ Last accessed February 1, 2012

[124] Mostafavi, Mohsen, and Gareth Doherty. 2010. *Ecological urbanism*. Baden, Switzerland: Lars Müller Publishers.

public transportation model within the eco-city was thereby perceived to be "the first attempt to move away from a traditional transport system to an on-demand system that allows almost door-to-door service – and innovation in the world of transport. And maybe a first step to a better future."[125] One blogger[126] who reviewed the exhibit suggested, "The comfort and safety of the pods shows us a rather favorable vision of the future. Ride on cushioned seats, holding hands or facing each other. Have a conversation, catch up on the morning news. The car will stop to let you off at your chosen destination. Chauffeurs for everyone, and Green at that? That's our future? Not bad. Not bad at all!" The automated pod cars were thus widely celebrated and anticipated by their spectators. As the commentary suggested, it would have been aesthetically pleasant and enjoyable to ride in the PRTs in this undefined future.

And yet, the World Future Energy Summit was not the first occasion where the dream of an automated transportation system had been exhibited. The 1939 World's Fair, for instance, had included a General Motors exhibit, entitled Highways and Horizons,[127] where the future highway was perceived as a means of automation, restricting drivers to specified lanes and thus working towards preventing accidents.[128] While foreshadowing the Interstate Highways that later developed in the United

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[125] Ibid.
[126] http://alternate-power.org/zagatos-prt-pod-a-huge-hit-at-wfes/ Last accessed February 1, 2012
[127] See the brochure for Highways & Horizons exhibit: http://ia600308.us.archive.org/12/items/generalmotorshig00geddrich/generalmotorshig00geddrich.pdf Last accessed February 6, 2012
[128] Also see "Magic Motorways" by Norman Bel Geddes, the industrial designer who introduced the automated highway concept which was exhibited at Highways & Horizons: http://ia600208.us.archive.org/10/items/magicmotorways00geddrich/magicmotorways00geddrich.pdf Last accessed February 6, 2012

States, this exhibit was also a significant instance in which the concepts of automation and transportation were thought together. Yet the construction of the thus foreshadowed Interstate Highways, especially in the United States, became one of the significant reasons why the public transportation systems of the cities started being underfunded.[129]

It was only through the foundation of the Urban Mass Transportation Act in 1964 that research that would benefit public transportation began becoming more prioritized in the United States. Thus the concepts of automation and public transit were brought together in the 1960s, by researchers working with funding from the US government. Eventually, a report that included the various forms of public transit that should be pursued in the future was put together,[130] emphasizing the notion of automation. Personal Rapid Transit, along with Automated Dual Mode Buses and Dial-A-Bus systems, constituted part of the list. In the report, PRT's operations were outlined in the following manner, not very differently from how they would be explicated later in designing pilot PRT projects:

> Empty passenger vehicles or "capsules" would be available at each station on the network. The riders would enter one, select and register their destination, and then be transported there automatically, with no stopping. The average speed would be essentially equal to the vehicle speed. The station spacing on a guideway network for the system would

[129] For a discussion of automated transit, also see: Easterling, Keller. 2005. *Enduring innocence: global architecture and its political masquerades*. Cambridge, Mass: MIT Press, p. 108-113

[130] United States. 1968. *Tomorrow's transportation: new systems for the urban future. U.S. Department of housing and urban development. Office of metropolitan development. Urban transportation administration*. Washington: Government printing office, p. 60-65

> have no influence on speed of travel. Passenger demand and station costs would dictate proper station spacing.

While the system was discussed thoroughly, at the end it was argued that "control problems become even more complex in the areas of merging one vehicle stream into another and of routing numerous small vehicles automatically over a network of guideways, with provisions for switching off the line at stations, of maintaining adequate supplies of empty cars at stations, and of distributing vehicles so that congestion does not result on any line." Still, the results were optimistic, suggesting that in ten years and at a cost of $250 million[131] these problems could be resolved. Eventually, the Morganstown PRT system was established in 1975, at a time when public transit options were more sought out than ever, due to the oil crisis. However, the system was not replicated anywhere else in the United States because of its unexpectedly high costs. Other projects, initiated in Japan or France,[132] were also discontinued, resulting in an eventual disinterest in PRT infrastructures.[133]

And yet, research in PRT systems resumed again in 1990s, as climate change and energy security issues began receiving more attention, thus leading to projects such as Masdar City's PRT system, or its main competitor within Heathrow Airport,

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[131] Taking inflation into account, in 2012 this amount would roughly translate to 2 billion dollars.
[132] The French PRT network Aramis had also been displayed in a World's Fair in Paris in 1989. See Latour, Bruno. 1996. *Aramis, or the Love of Technology.* Cambridge, MA: Harvard University Press, p. 34
[133] For a comparative analysis of Intelligent Transportation Systems in United States, Japan and Europe see: Klein, Hans K. 1996. "Institutions, Innovation, and Information Infrastructure: The Social Construction of Intelligent Transportation Systems in the U.S., Europe, and Japan." Ph.D. diss., Technology, Management, and Policy Program, MIT.

designed by a company called ULTra.[134] These systems enabled the technology to be tested once again, this time within a different social, economic and political context.

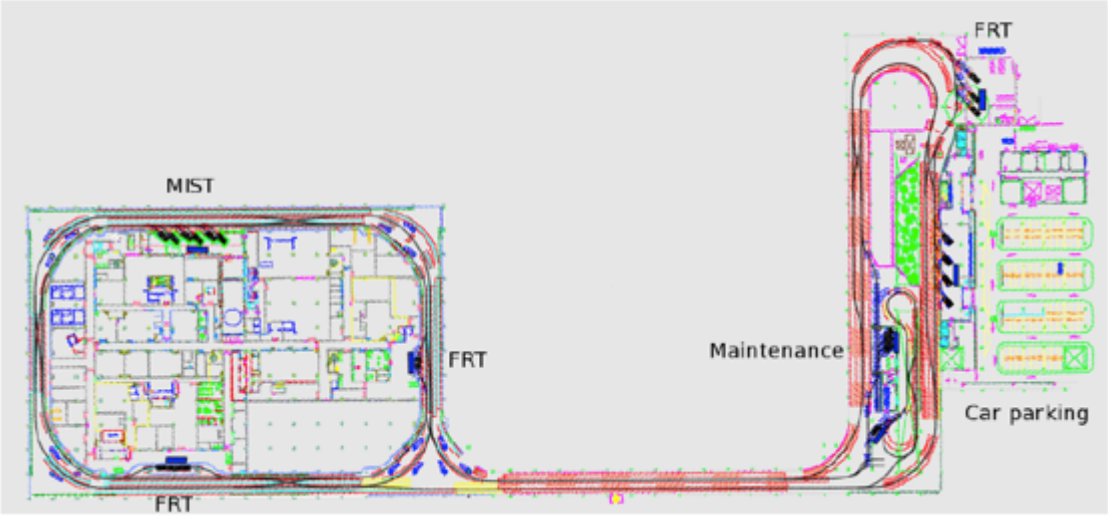


Figure 13 Plan of Pilot PRT Track between Masdar Institute and Parking Lot[135]

Soon after Masdar City's PRT pods were unveiled at the World Future Energy Summit, the Treehugger website interviewed Luca Guala, the transportation planner working with the eco-city.[136] In the interview, Guala not only gave a detailed explanation of the individual pods, stating how they would speed up to 7 meters per second making the longest travel time within the city 7-10 minutes in total, but also provided more information about the possible infrastructure of the PRT. First, passengers would descend a flight of stairs or take an elevator to the station at the

[134] For a quick overview of the ULTra PRT system, please see: http://www.ultraprt.com/heathrow/ Last accessed February 9, 2012
[135] The image is available at: http://www.advancedtransit.org/wp-content/uploads/2011/08/PRT-Vehicle-Architecture-and-Control-in-Masdar-City-M.-de-Graaf.pdf. The article also provides a detailed technical description of the PRT infrastructure at Masdar City. Last accessed February 9, 2012
[136] http://www.treehugger.com/cars/abu-dhabi-to-debut-personal-rapid-transit-apodcarsa-later-this-year.html Last accessed February 1, 2012

undercroft. Next, there would be two options, he said, "You will swipe a smart card through a machine, and a welcome message will appear. One option is that the system will recognize you and greet you personally: "Good morning, where do you want to go today?" Perhaps the system will remember your usual path, and offer it to you as an option. After you click on your destination, the system will say something like, "Your car is arriving in 2 minutes at platform number 3." You may have to stand on a line, and you will be able to identify your car by its number. The second option is that you will enter your destination into the system when you are already sitting inside a car." Then, passengers could step into a pod that is fully charged, and press go on the touchscreen control panel.

However, Guala highlighted the limits of the PRT system as well, and warned the interviewer that if there happened to be a Rolling Stones show at Masdar, then the PRTs would probably suffer, especially because they were not designed for such heavy influx of people. They could serve the Masdar City residents, seating four, or even six passengers inside each pod, but they would perhaps need to be complemented with light rail systems with higher carrying capacities. He also emphasized that this was a prototype, somewhat similar to the widely discussed Morgantown PRT project from the 1975,[137] and prototypes were definitely expensive.

[137] See more about the Morgantown PRT project here:
http://www.nytimes.com/2007/06/11/us/11tram.html?_r=1&oref=slogin Last accessed February 3, 2012

Following two years of discussions on the implementation of the PRT at the city-scale, however, the project proved to be more difficult than it seemed. In September 2010, when I arrived at Masdar City to start conducting fieldwork, rumor had it that the plans for the PRT had already been dropped, but not yet made public. "Unfortunately, recent (October 2010) announcements indicate that [the] plan has now been scaled back and the PRT system will be confined to a pilot system or a small system serving the area close to the Masdar Institute of Science and Technology. This is a blow to PRT proponents, but is PRT to blame for the setback?" one follower of the project asked soon after,[138] and provided an analysis of why exactly the city-scale PRT project had been cancelled. "O, vehicle of the future, why have you eluded us?" another website wrote,[139] inquiring into how and why innovation was so difficult within the transportation sector.

The main reason for scaling down the project, as many of my interlocutors confirmed, had been the podium-undercroft logic, wherein the city would be raised six to seven meters above ground, providing a basement space for the PRT tracks. This plan had become a problem for several reasons, including routing constraints, but it was argued that the most important factor had been the project's costliness. The ecology blog Green Prophet, an ardent follower of issues related to Masdar City, reported:

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[138] www.prtconsulting.com/blog/index.php/2010/10/16/why-has-masdar-personal-rapid-transit-prt-been-scaled-back/ Last accessed February 1, 2012

[139] http://singularityhub.com/2011/03/01/masdar-city-abandons-public-transportation-system-of-the-future/ Last accessed February 1, 2012

> Masdar gave us the perfect opportunity to take the next giant leap but we slipped and fell, our *Fifth Element*[140] fantasies dashed in the process. Alas, the tiny self-navigating pods were simply too expensive. Or at least, the infrastructure necessary to lift them off the ground would have broken an already strained budget.

Others who wrote about the PRT line wondered if there could there have been any other way of building the city. Could better planning on the part of the Masdar City master-planners have resolved this issue? Perhaps developers could have been given stringent guidelines regarding how to situate buildings, thus allowing space for the PRT tracks between the buildings. While the debates about the PRT system continued, they did not change the decisions about the cancellation of the project at the city scale. Rather, they brought together different actors into the same conceptual domain, igniting further thoughts on the future of transport systems.

In responding to the arguments about the project's costliness, Sylvia from 2getthere, who was based in Abu Dhabi for the Masdar PRT project, stated, "You know, the pod cars all hand-made, so they are costly, but if there was more demand, and if we started a factory, costs could have been brought down. Also, we really didn't need such expensive stations with large screens and everything. All we needed was a door, so in fact the costs could have been brought down drastically," thereby pointing to possible miscommunications or decision-making problems. In this way,

[140] *Fifth Element* is a 1997 science fiction film by Luc Besson, which featured transport systems reminiscent of the pod cars.

she implied that a lack of coordination amongst different actors within the project had caused the city-scale PRT infrastructure to be dropped.

Still, the cancellation of the PRT project at the city scale had re-opened the discussions regarding the advantages and disadvantages of the technology. Some, who were less fond of the pod cars, wrote that the PRT model was flawed to begin with, and commented how this would be a new addition to the history of failed personal transport projects, such as the French PRT project Aramis. Lists of reasons were provided regarding how and why the PRT had actually been a bad idea from the start. The Masdar PRT infrastructure was specifically criticized for its inefficiency, because its energy input was from Lithium powered batteries, rather than power generated on the guide-way, in a way like trams. This feature would surely limit how frequently a pod car could be used, as each pod car would require extra time to be charged at the station.[141] Another commentator, discussing the Masdar project along with the ULTra PRT system in the Heathrow Airport, wrote, "[These] are essentially automated, battery-powered golf carts - neither are *personal* (passengers sit awkwardly across from one another, knees almost touching), *rapid* (bikes are faster) or *transit* (totally lacking capacity)."[142] In this way, the writer dismissed the PRT infrastructures from the start, and noted how what they promised was not a substantial or desirable development for the transportation sector.

[141] http://everythingexpress.wordpress.com/2011/12/29/review-masdar-city-personal-rapid-transit/ Last accessed February 6, 2012
[142] http://prtboondoggle.blogspot.com/2010/12/masdar-and-heathrow-prt-still-not.html Last accessed February 9, 2012

In scholarly literature on public transportation systems as well, PRT has not always received credit.[143] Vuchic,[144] for instance, argues that "the basic concept of PRT was inherently unsound," and that "the PRT mode is impracticable under all conditions." He further explains that the main objective of the PRT concept, which basically constitutes bringing together the advantages of private cars and public transportation, would not be achieved without simultaneously experiencing the major disadvantages of the highway system in urban areas, such as "high costs, large space requirements, low capacity, and poor reliability." Consequently, PRT, he argues, is an unrealistic solution rather than a "future transit mode." Vudvij also proposes that a 21-station system PRT would be up to 400 times as expensive, slow and unreliable than a conventional system. In this way, he somewhat agrees with the comment that the PRT is not a desirable technology to begin with.

While the scaling back of the Masdar project did not comprise a concluding remark on the discussions regarding PRT technology, it regenerated a decades old debate on the pod cars and their potential applicability in the transport sector in the upcoming years. In some sense, the cancellation of the project had brought together different actors around the same table, creating debate around the PRT. Masdar would start experimenting with electric cars, I often heard, and soon started seeing small Mitsubishis being test-driven around the building.

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143 Gilbert Richard and Anthony Perl. 2008. *Transport Revolutions: Moving People and Freight Without Oil.* London: Earthscan.

144 Vuchic, V R. 2007. *Urban Transit Systems and Technology.* John Wiley & Sons: New York, p. 474

"It's difficult to foresee what will happen next with Masdar," Sylvia told me, as we chatted inside the PRT station by the parking lot, months after the cancellation of the project had been made public. She pointed to the large model, provided by Foster + Partners to represent the first phase of Masdar City. "As you can see in this model, the PRT moves throughout the buildings, but those plans have been discontinued, though here it is still being advertised as if the city included the PRT." According to Sylvia, this partially proved how the PRT attracted more people to the city, making it a more desirable destination than it was. It also showed how the imaginaries of a future Masdar still had some footing inside the city. Although they had been dropped, the plans for PRT still retained their significance in Masdar City's image, as the "futuristic sci-fi eco-city" that it communicated itself to be.

But was the cancellation of the project at the city-scale conceptualized as failure? Or was the PRT actually a success, given the existing prototype that operated between the Masdar Institute campus and the parking lot outside the building? While the frequenters of Masdar Institute worried less about the cancellation of the project, and about defining it as failure or success or neither, they continuously attempted to assess if the existing pilot PRT line worked.

**Sand, Debris, Birds**

A journalist from *TIME* magazine had perceptively described the personal rapid transit system at Masdar City in a recent article:[145]

> The doors swish shut and with the press of a touchscreen button, the Personal Rapid Transit (PRT) car is off, gliding through the tunnels beneath Abu Dhabi's new Masdar City. The sleek four-passenger vehicle — which looks like something out of the movie *TRON: Legacy* — runs on an electric motor, making it clean and carbon-free. There are no tracks — the car is autonomous, driven by a computer that charts direction with the help of tiny magnets embedded in the road. When my PRT car senses another vehicle waiting in our parking space, it stops and waits for the area to clear, avoiding a collision. PRT is meant to be the future of mass transit within cities, with the environmental benefits of buses and trains but the freedom of a private vehicle. But as my car pulls into an open docking bay, I can't help thinking there's something slightly silly about all this. For all the technology — which isn't cheap — the PRT has taken me to its one and only stop, maybe half a mile (800 m) from the starting point. For a lot less — and not much more time — I could have used a much older form of transport: my legs.

When I asked Sylvia from the PRT subcontractor 2getthere how she would respond to the argument about the fact that bicycles or simply walking could have been utilized in the short distance between the campus and the parking lot instead of this complicated technological system, she told me, "As a system the PRT is accessible by everyone, wheelchairs, old people, push chairs, there is no step leading to the vehicles. Not everyone can walk or take a bike. In that sense, this system is very open. And it is emission free." For them this short line between the parking lot and the Masdar Institute building was an opportunity to test a transportation system that was still

[145] http://www.time.com/time/health/article/0,8599,2043934,00.html Last accessed April 11, 2012

under development, in an inclusive manner. The technology could later grow and spread around the world. Later Sylvia continued, "And many people come to Masdar for the PRT," she said, "People enjoy it as well."

Figure 14 Visitors to Market Day waiting for the PRT

Given the long lines at the PRT stations, the Market Day @ Masdar was an occasion that triggered much discussion not only about the PRT system and its applicability to a city, but also about what exactly constitutes failure for this new prototype. The crowds that attended The Market Day had also given Sylvia the opportunity to rearticulate her ideas about how people enjoy the PRT.

"About 4000 people took the PRT that day," Sylvia told me, "there were huge lines, and I was going and telling people standing in line that there is a bus they can

take, but they refused to take the bus, they'd rather stand here and wait, they said they came here to take the PRT." Sylvia saw this as a clear victory for the project. However, she admitted, "Some people understand that as a failure because there were long lines. The system is not designed for such heavy demand, you must understand, our target is the residents at the Institute, which is very small. Now slowly there will be people coming for the retail space here, which will be reached mainly by the PRT." In this way, Sylvia rearticulated the capacities and the target market of the available PRT line. "But others may have misunderstood," she clarified.

# Campus

## Sustainable living, sustainable learning

**At the beginning of the academic year of 2010, Masdar Institute moved into its new campus in Masdar City. Completion of Phase 1 of the Masdar Institute Campus saw the opening of a complex structure that includes laboratories, dormitories, classrooms and faculty offices, among other amenities. The Masdar Institute campus has clean technology at its core and innovation at every turn.**

## Our buildings

The Masdar Institute campus gives an insight into the ways the future city will pursue sustainability, and a wander through the complex is illuminating. The campus, which consists of a main building, a knowledge center and students' quarters, will use significantly less energy and water than business as usual. In particular, residential quarters of the complex are designed to use around 51 percent less energy than average buildings in the UAE, and 54 percent less water.

The buildings' façade and roof are of high thermal performance, highly-sealed and insulated material. The buildings' windows and openings have been designed to optimize daylight into the interiors to reduce artificial light reliance.

Low flow water saving fixtures are installed as standard and grey, condensate and rain water are harvested and recycled for irrigation to minimize both use and waste of water.

## Our transport

Masdar Institute is part of a low-carbon transport system. Fossil-fuel powered vehicles are parked outside the premises and personal travel takes place via the electric-powered, large-scale, rapid transit system.

As part of our low-carbon transport culture, the campus has pedestrian colonnades with retractable screens that are closed during the day to provide shade and are opened at night to purge warm air and collect cool breezes.

## Our innovations

Inspired by traditional elements of Arabian architecture, a six-storey wind tower in the central courtyard of the campus helps bring cool air down to ground level. The tower also broadcasts the levels of energy use at the campus, and is lit in red when energy use is high and is lit blue when energy use is below its ideal usage.

Laboratory façades have been developed to provide glare-free daylight and solar control without impacting views out of the building. Student accommodations have been designed with the latest low energy lighting systems and a low energy 'sleep mode' when the rooms are unoccupied.

Personal Rapid Transit vehicle

Figure 15 PRT pods showcased inside a Masdar Institute catalog

On the other hand, Brad, who worked as an executive at Masdar, argued, "On Market Day @ Masdar, we witnessed the failure of the PRT. It is just not very practical. It does not work for a city. We saw that you cannot just pay, and buy efficiency like that." The long lines had proved to him that this was not an appropriate way of organizing the city's transport system. "The PRT is the nervous system of this city," he underlined, "the moment it stops working, the whole city fails." Regardless of the aesthetic pleasure that the crowds derived from taking the PRT, according to Brad, the system had been incapable of transporting these crowds from one point to another, thereby not performing the most essential function of a transport system.

The nervous system analogy Brad used implied "control, hierarchy and intelligence," as Michael Taussig[146] puts it, in addition to an ever-present incompleteness, and "constant need for a fix." In this way, it helped Brad explain how the city was paralyzed due to long PRT lines. Acting as the center of control, hierarchy and intelligence, the experimental transportation network had kept the visitors stuck at the parking lot, somehow preventing them from accessing the building. In some ways, Brad saw the nervous system of Masdar as diseased. While for Sylvia the long waiting times showed how desirable, and thus successful, the PRT was as a technology, for Brad they represented the failure of a system that prided on its user-friendliness and flexibility. Likewise, while Sylvia understood the Market Day

[146] Taussig, Michael T. 1992. *The Nervous System*. New York: Routledge.

@ Masdar as outside the everyday of Masdar Institute, Brad saw it as an event that very much constituted the daily life of the emergent eco-city.

Such debates, coming to life through nonetheless uncommon experiences such as Market Day @ Masdar, allowed the producers and users of the PRT to define their expectations of this infrastructure and develop understandings of what constitutes failure or success. In this way, the debates were crucial, providing space for the frequenters of the city to define how they understand this new technology.

Many who visited the site for Market Day @ Masdar also wanted to know how exactly the PRT works. When a friend of mine, who was visiting the campus for the first time, and I took our turn riding the PRTs, much later in the evening, after the crowds had dissipated, Salim, a mechanical engineering student at Masdar Institute explained, "See those red boxes underneath the pods, the pods are charged through those boxes, through induction technology. I believe it needs to be charged for five minutes for every two trips? And then the PRT begins to travel on the magnetic lines that are embedded, see those black lines on the ground, they're not tire marks," he said, "They are the tracks on which the PRT moves." Next, he pointed to the supervisory system, which consisted of wires above the tracks. The supervisory system allowed the PRT to survey its surroundings before making the decision to move. After listening to his thorough explanation, I asked Salim why the PRT breaks down from time to time. "It mostly works well," he initially said. Later he turned to Elif, who sat next to him inside the pod, and started giving details regarding the

system's problems. "I believe they just really need maintenance," Salim explained, "this pod keeps going back and forth all day, it has suspensions, breaks, break pads, sensors. Sensors need to be calibrated all the time." In attending to the potential problems of the pod car, he found it necessary to break it into parts, and specify what each element within the pod car required. "Also the road is not that smooth and that's why the suspension is always problematic," Elif continued, "That's why it needs a bit more maintenance." When we arrived at the parking lot, the pod car had announced, "The doors are opening, please mind the doors," and Salim concluded, "I hope you enjoyed the trip!" My friend asked if we could go back and forth in the pod car once again.

Like most transportation systems, the PRT requires specific infrastructure, which may at times be difficult to put together or maintain. For instance, the invisible magnetic track on which the PRT traveled had to be as smooth as possible, with miniscule bumps. Sylvia underlined that asphalt would have been the ideal material for such even flooring. "One problem with the Masdar system," she continued, "is that they wanted to use concrete from the sustainable concrete plant on site, produced from recycled materials." This was part of the sustainability guidelines that Masdar City adopted when they first started construction. "This is of course great," Sylvia admitted, "but then again, it is not the best road for the PRT to operate. Asphalt would have been much better," she repeated, once again.

But the flooring was not the only problem with the PRT, according to Sylvia. "This is still a pilot project, and its supervisory system needs to be improved," she said, "You see the wires running along the magnetic strip on top of the PRT, those wires constitute the supervisory system, they detect where the PRT is, if there is anything in front of it, if it should stop or if it can go on." The supervisory system had to be very sensitive, so that the driverless pods did not crash. "So if a bird enters this space," Sylvia continued, "then the PRT stops immediately because it thinks that it's going to hit the bird." According to Sylvia, 2getthere had preempted this problem, and asked for high walls to surround the PRT tracks. Under such conditions, the PRT would have been contained inside what seemed like a subway tunnel. "If the walls had been higher, if there were no openings than we would be doing a better job, especially because no sand, no debris or no birds would enter," she explained, "But these are about the local context," suggesting that the problems with sand, debris and birds was not inherent to the technological system that they had devised, but were instigated by the context in which the technology was being put to use. "We expected the walls to be higher, but for some reason they were built in this manner." In this way, she touched upon the problems of communication between Masdar and its subcontractors, leading to various difficulties for the multiple producers of this city (see chapter 3 for more information on such difficulties).

After giving me such detailed explanation of technical problems, Sylvia took a break, and walked me to the PRT doors to show how the runners below the doors

were full of sand. "Most difficult for us," she then continued, "are the spaces where two systems get in contact, for instance, the point where the door and the PRT interact." Her comment sounded like an analogy, wherein she described the relationship between different parties involved in the production of the PRT. While she explained the interaction between the doors and the pods, I thought of the interaction between Masdar and 2getthere, and the uncertainties that characterized their relationship. Then Sylvia continued, "If they chose to implement an additional transportation system, I'm not sure how or if it could be seamless. In London, where I'm from, it works, I mean you have metro, a bus, a cabstand, but I'm not sure how it would function here." She said she didn't know what would happen next with the project, and pondered how long her team would remain in Abu Dhabi.

Although they did not come up in my conversations with Sylvia, there had been other occasions that seemed to define failure for PRT pods at Masdar City. The day when a committee from Switzerland came to visit the Institute, for instance, and presented a windmill-like sculpture to be placed inside one of the courtyards on campus, had been one of those times when the PRT failed. Following their site tour, the committee had been guided to the undercroft to take the pod cars to the parking lot, only to realize that the system was down. They had waited at the station for some time, but then were taken upstairs to take a regular shuttle bus to the parking lot. The

tour guides had apologized to the committee, and explained that this was an experimental system, so it was only natural that it malfunctioned sometimes.[147]

But this was not the most prominent account about the failure of the PRT. Rather, the imminent failure of the PRT was most often communicated through the story of the burning pod, circulating around the Masdar campus. I had first heard about it from Michael, a post-doctoral researcher at the Institute, perhaps in early December. The overcharged PRT pod had gone up in flames a day before the Masdar City inauguration ceremony on November 23rd 2010, thereby preventing it from being showcased. "No one was allowed to ride it for a few days," Michael had reminded me, "and then they began using only the semi-charged ones." I recalled how he had jokingly pointed to the hatchet that was safely positioned underneath one of the seats, and told me that I should use it in case there is a problem again. The burning pod car had then transformed into a somewhat mythical object, referenced on and off inside the Masdar Institute building, and tying the Masdar Institute students through a shared remembrance of the event.

[147] When Hillary Clinton paid a visit to the new Masdar Institute campus, Masdar authorities prepared for her to enter the building by taking the PRT. Clinton's security guards studied the PRT pods carefully, and reported that she could not ride the experimental transit system. Eventually, she was taken to the Institute by car. The security guards had not been able to figure out what it would mean for the emergent transit system to be safe, and thereby preempt its possible risks and uncertainties. In this case, it had proved more logical for the Secretary of State to travel by car, a means of transport that the security guards were more familiar with. However, the Hillary Clinton story at times became bundled up with other stories of failure, and became interpreted as one such incident.

## An Expensive Toy

Sylvia was perhaps right; it was an "experience" to be inside the PRT, and to enter the Masdar Institute building through the beautifully designed undercroft station, where a large screen played an occasional waterfall loop. Later, the loop was replaced with info-screens that provided details of climate change, renewable energy or clean technologies related developments from around the world. A sculptural staircase greeted the PRT passengers, attempting to entice them not to use the elevator, but rather to walk upstairs to the Masdar Institute reception and laboratories. The aesthetic pleasures of the staircase were expected to be forceful enough to reorganize everyday habits. Some post-doctoral researchers and I often spoke about what a wonderful space this station would be for a party, knowing that this party would perhaps never take place. We "enjoyed" the PRT pods, as well as their picturesque undercroft station.

Figure 16 The PRT Station at Masdar Institute

The idea of "enjoying the PRT" was significant to the way Sylvia talked about this system as well, seemingly implemented for functional purposes. In this conception of the technological infrastructure, the PRT inhered affective qualities. Accordingly, the observation that the visitors to Market Day @ Masdar refused any other means of transportation, such as a shuttle bus, possibly meant that they did not understand the PRT as a means of transportation per se, serving to take them from one point inside Masdar City to another, but rather as play. In this framework, the visitors had abandoned their possible routine, which may have comprised taking shuttle buses, and arrived at Masdar City with the expectation of a spectacular experience. Sylvia interpreted the PRT to be a successful experiment, because

newcomers to the site "enjoyed" it, as a means of play. As a medium of everyday transportation, however, the system did not manage to cope with such unprecedented demand. This difference had perhaps instigated the disagreement between Sylvia and Brad in regards to the efficacy of the PRT technology.

"Anyhow, when they stop building it, and finally give up on the clean technology cluster, this city will probably transform into an amusement park, don't you think," one of the post-doctoral researchers asked me, possibly making a reference to spaces like EPCOT,[148] originally conceived of as futuristic communities, but later abandoned to constitute objects of play. According to him, in a few decades people would come and visit the ruins of an eco-city, or what was meant to be an eco-city, wherein the ruins would signify not only decay but also traces of an idea, or, as Benjamin would put it, a "wish image," once pursued ambitiously. In this imagined future, Masdar would become a spectacle, more than it already was, and its ruin would once again offer amusement, or rather enjoyment to its spectators, in addition to nostalgia for a past where the option of a renewable energy and clean technology future was still available. Yet the enjoyment provided in this case was different from the aesthetic pleasures of the staircase, the undercroft, or of the PRT ride. While the experience of artifacts such as the staircase, the undercroft and the PRT ride exemplified the work towards embedding the sustainable utopia of Masdar within the

[148] EPCOT is a theme park in Orlando, Florida. While originally designed and conceived of as a city for twenty thousand residents where ideas about planning would be experimented with, the city was finally opened as a theme park in 1982.

everyday, and thus producing an understanding of sustainability that relies upon and promotes technoscientific experimentation, the ruins denoted a possible surrendering of that ideal, within a future wherein this perception functioned as a relic.

The idea of enjoyment proposed in these conversations was not completely new to me, as I had often heard students at Masdar Institute refer to the PRT as an "expensive toy," rather dismissively. Especially when the pods malfunctioned, at times getting stuck mid-way on the magnetic tracks, mostly because of sand, debris or birds, my co-commuters would begin to complain. They would later generalize such comments to the rest of Masdar City, suggesting that the whole project of sustainability that characterized Masdar could be considered as such lavish play, instituted by decision-makers that were not always directly in touch with the students needs or activities. "We could have just walked, rather than sit here inside this pod, the building is just there," they would protest, and at times promise to each other that they would take the shuttle bus next time.

But what did it mean for an experiment in sustainability to be perceived as an "expensive toy"? Studying the idea of toys and play in three short essays, Walter Benjamin underlines how it is perhaps the authoritative adult that creates and provides toys to the child. While the child possesses the capacity to make use of these toys through re-imagining them, as Benjamin puts it, "a not insignificant proportion of the oldest toys (balls, hoops, tops, kit**e**s) are in a certain sense imposed on [the child] as cult implements that became toys only afterward, partly through the child's

powers of imagination."[149] He thus continues to suggest that it is not the child's needs that determine the toys that are provided to him or her, but rather the adult's imposition of a particular idea of the world. In the case of the PRT pods, it could perhaps be argued, the experimental transportation infrastructure had been offered, by producers of Masdar City, as a "cultic implement" to the people, who frequented the campus, to serve as an effective means of transit within the emerging eco-city. However, instead of performing to be the efficient transportation system that it promised, the PRT had been re-imagined by the community that it serviced as a toy, marking their participation within an experiment with sustainability. While Benjamin makes a clear distinction between the adult as the provider of the toy and the child as the user, perhaps the sides are not always that clearly cut. In the case of the eco-city, the producers of the PRT infrastructure, such as executives at Masdar or 2getthere, used the PRT, as an "expensive toy" as well, being entertained by its futuristic capacities of automated transport. They had become both the adults and the children of this technological toy.

However, there is a more significant characteristic that toys embody for Benjamin, especially when thought together with ideas of sustainability. Towards the end of his short essay on toys and play, Benjamin argues that what unites these two concepts as embodied in the German word *spielen* is that they are "Not a "doing as if"

[149] Benjamin, Walter. 2005 "Toys and Play: Marginal Notes on a Monumental Work," in *Walter Benjamin: Selected Writings, Volume 2, part 1, 1927-1930 (Walter Benjamin)*. Cambridge: Belknap Press, p. 118

but a "doing the same thing over and over again," the transformation of a shattering experience into habit – that is the essence of play." As such, he proceeds to state,

> For play and nothing else is the mother of habit. Eating, sleeping, getting dressed, washing have to be instilled into the struggling little brat in a playful way, following the rhythm of nursery rhymes. Habit enters life as a game, and in habit, even in its most sclerotic forms, an element of play survives to the end. Habits are the forms of our first happiness and our first horror that have congealed and become deformed to the point of being unrecognizable.

In this sense, Benjamin points out, how when playfully done, practices may be quickly adopted as habits. Could it then be argued that the practice of lavish repetition, trips back and forth on the PRT, as sustainability was a means for generating a habit of environmental sensitivity amongst the inhabitants of Masdar Institute? And what kind of habit would that constitute? Or what kind of sustainability?

And yet such repetition, thus the associated habit, may at times manifest itself as a form of collectivity formation as well, for instance in the repetition of a ritual to which only certain people may attend, and which takes place at a certain time within a certain space. In such contexts where play becomes something that is associated with a specific time and space, enjoyed only by members of a collectivity, the perception of play transforms from being about an individual becomes characterized by its relationality to others – in other words, in its ability to bring people together as a

collectivity. In this framework, the collectivity that one participates in becomes more significant than the actual artifact that is enjoyed by the collectivity.[150]

Experienced together, within a particular time and in a bounded space, the PRT had also allowed the frequenters of Masdar Institute to form a collectivity around this specific aesthetic experience. Collectively, they had "enjoyed" the experimental infrastructure, and preferred to wait in line to take the PRT rather than commute to the Masdar Institute campus by using a shuttle bus. Others had joked about its breakdowns, and called it an "expensive toy." Could aesthetic experiences, shared by specific collectivities, then constitute a means through which sustainability would be embraced as a habit? Where did play lie in creating and reproducing sustainability as an everyday strategy?

**Rewiring the Nervous System**

Perhaps it would be accurate to state that the PRT had not delivered what it promised to be. It did not connect the city through a network of pod cars, it was very costly, and the existing pilot PRT line malfunctioned frequently. But through the

[150] Giorgio Vattimo underlines how this transformation of the beautiful also shows us the transformation from ideas of utopia to ideas of heterotopia, wherein utopia is characterized by the universal aesthetic enjoyment it offers, as opposed to the particular and selective nature of heterotopia, wherein the focus is not necessarily the work of art, but rather the experience of this work, together with a particular community. He explicitly states, "Aesthetic utopia comes about only through its articulation as heterotopia. Our experience of the beautiful in the recognition of models that make world and community is restricted to the moment when these worlds and communities present themselves explicitly as plural." Vattimo, Gianni. 1992. *The transparent society*. Baltimore: Johns Hopkins University Press.

aesthetic enjoyment of the pod cars, a collectivity was formed around the experimental transport system, wherein ideas of "enjoying" the PRT came to fore, more than anything else. Could a system which proved to be a "failure" in its inability to perform as the transportation infrastructure of the future, actually be understood as a "success" in binding the frequenters of Masdar Institute together, through shared play? The PRT went back and forth for 18 hours everyday, and formed a heterotopia around its iterability.

Discussing elements of play in Iranian cinema, and their ability to open up new regions of consciousness, Michael M. J. Fischer[151] writes,

> Play is the repetitive iterability that is given license in ludic performance, the virtuality of possible futures that can be experimented with. Models of such mimetic "innervations" or rewirings of the nervous systems of both the individual body and the collective civic body include childhood, writing, advertising, dreaming, eros, and politics (Miriam Hansen 2002, 61; Taussig 1992). The child, as Benjamin reminds us, "plays at being not only a shopkeeper or teacher, but also a windmill and a train"; children practice inventive reception of a new world of things (Miriam Hansen 2002, 61).

In this framework, Fischer suggests, childhood, writing, advertising, dreaming, eros and politics are models of a rewiring of the nervous system for the individual and the civic body. Did the PRT, the nervous system of the city, as Brad called it, also go through a possible rewiring through play? Perhaps it was its repetitive iterability that enabled the PRT to ontologically transform from a transit mechanism to an expensive

[151] Fischer, Michael M. J. 2004. *Mute dreams, blind owls, and dispersed knowledges: Persian poesis in the transnational circuitry*. Durham, N.C.: Duke University Press, p. 387

toy. Through communal efforts at play, not only the collectivity around the PRT had gone through a rewiring, where their expectations of the transport device transformed, but also the PRT system, where it no longer served as an effective transit mechanism, but rather as an expensive toy.

What would a rewiring of its nervous system do to the eco-city that encased this expensive toy? Did Masdar City, like the PRT, transform from being an effective eco-experiment to being a performative toy, offering amusement to its visitors both in the present and in its projected ruin?

In the next and final chapter, my ethnography will go underground, to explore how innovations in policy-making related to carbon capture and storage also provided an arena through which Abu Dhabi would prove its commitment to the development of renewable energy and clean technology infrastructures.

## CHAPTER FIVE:

## SUBSURFACE WORKINGS: THE MAKING OF GLOBAL CLIMATE CHANGE POLICY IN THE UAE

### Preparations

On December 4th 2010, the United Nations Climate Change Conference in Cancun agreed upon the inclusion of carbon dioxide capture and storage in geological formations (CCS) as an eligible option for mitigating greenhouse gas emissions. This meant that the United Nations Framework Convention for Climate Change (UNFCCC) would include CCS in its Clean Development Mechanism (CDM) program, and grant carbon credits for the carbon dioxide captured from industrial compounds and stored in underground spaces such as deep saline aquifers, unmineable coal seams, or declining oil and gas fields, specifically in Non-Annex I, i.e. so called developing, countries.[152] In further negotiating the means through which CCS would be adopted as a mitigation strategy, interested parties were invited to submit modalities and procedures guidelines to the UNFCCC that would address and resolve issues such as safety and liability protocols.[153]

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[152] For a list of Non-Annex I countries, see: http://unfccc.int/parties_and_observers/parties/non_annex_i/items/2833.php Please note that the United Arab Emirates, along with many other oil producing countries, is included within the list. Last accessed October 1, 2011.

[153] These issues had been identified in United Nations Framework for Climate Change (UNFCCC) Decision 2/CMP. 5, paragraph 29. Paragraph 29 specifically stated that the United Nations, "*Recognizes* the importance of carbon dioxide capture and storage in geological formations as a possible mitigation technology, bearing in mind the concerns related to the following outstanding issues, inter alia: (a) Non-permanence, including long-

In this chapter, I explore the emergence of CCS as a climate change mitigation strategy by studying the production of a modalities and procedures guidelines submission in Abu Dhabi, the United Arab Emirates. I rely on ethnographic fieldwork with consultants at Masdar Carbon, as well as meetings with representatives from Abu Dhabi National Oil Company (ADNOC), Abu Dhabi Company for Onshore Oil Operations (ADCO), the Directorate of Energy and Climate Change (DECC) at the Ministry of Foreign Affairs, and the UNFCCC to examine the ways in which the subsurface became reconstituted as a frontier that would bring forth previously unavailable benefits and challenges through potential CCS projects. Underlining the multiplicity of responses that the document production process triggered amongst participants, I investigate the tensions that arose between the consultants at Masdar Carbon and the engineers and scientists at ADNOC and ADCO during preparatory meetings, and lay out the ways in which these parties had to translate across their areas of professional comfort. I thereby stress how conceptions and practices of risk management were utilized in conjuring "degrees of acceptable risk," and facilitating the favoring of CCS as a climate change mitigation technology. I argue that such "degrees of acceptable risk" become critical factors not only in establishing CCS methodologies, but also in reframing climate change as a commercially viable venture that may serve as an economic opportunity.

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term permanence, (b) Measuring, reporting and verification, (c) Environmental impacts, (d) Project activity boundaries, (e) International law, (f) Liability, (g) The potential for perverse outcomes, (h) Safety, (i) Insurance coverage and compensation for damages caused due to seepage or leakage."

Upon the declaration of the Cancun CCS decision, some policy consultants at Abu Dhabi's Masdar suggested that it was a surprise, and celebrated its multiple prospects. This could be a turning point for an oil exporting country like the United Arab Emirates, others excitedly argued, as it would avail future options for low carbon oil production and usage, while providing opportunities to earn carbon credits. Besides, it was a perfect occasion for the UAE to demonstrate and publicize its commitment to sustainability goals, and to improve its image in the international policy sphere. As such, the eventual inclusion of CCS as a climate change mitigation strategy could lead to a major diplomatic success, contributing to the UAE's transformation into a real leader in the international world. Therefore, when it was announced that interested parties could submit modalities and procedures guidelines regarding how carbon capture and storage projects should be initiated, maintained and monitored, the consultants at Masdar immediately began working on the document, cooperating with other stakeholders; ADNOC, ADCO and DECC. The document had to be submitted to the UNFCCC by February 21st 2011.[154]

[154] The environmental consultants at Masdar, as well as the other participants to the preparation of the modalities and procedures submission, have advanced engineering degrees. They come from different countries around the world, and mostly are in the UAE for temporary periods. The individuals who informed this essay, through meetings, interviews or informal conversations, specifically originated from Algeria, Germany, India, Iran, Lebanon, the United Arab Emirates, and the United Kingdom.

## Carbon Capture and Storage

CCS is a controversial technology that operates by procuring carbon dioxide from localized sources of pollution, such as power plants, carrying it in solid, liquid or gas form to storage sites, and injecting it into the underground (see Figure 1 below). CCS projects may bring about the leakage and seepage of concentrated amounts of carbon dioxide from storage sites, and short or long-term liability protocols related to such incidents are not yet in place. Furthermore, issues such as selection of storage sites, monitoring plans for leakage and seepage of carbon dioxide, or transboundary effects of gas injection have to be actively addressed in negotiating for CCS projects.

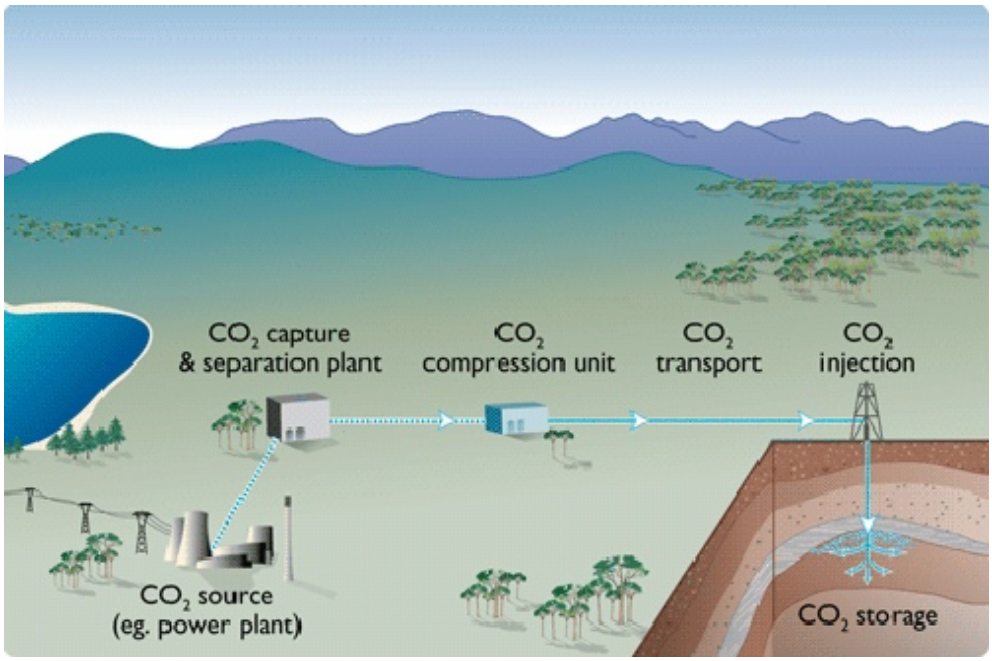


Figure 17 Carbon Capture and Storage

"We are working at least three kilometers underground," Marwan, a consultant at Masdar, emphasized, in explicating the various risks and uncertainties of CCS. When I asked him how he would define the consultants' role in the implementation of CCS as a climate change mitigation strategy, he stated: "The whole exercise is a risk assessment for future risks. We need to define the mitigation action and to reduce the risk. But the risk can be managed. All we have to do is to define who will be in charge of the risk, and mitigating the risk, and taking care of the accidents." After referring to the Fukushima incident in Japan, which at the time of our conversation shook the energy industry considerably, he highlighted: "There is always error. We just need to be prepared." Marwan thereby reframed the production of the modalities and procedures guideline submission as a process of manufacturing a set of directives, which would be used before and after an inevitable accident or disaster befalls a CCS project. However, Marwan's words underlined that a surgical mapping and managing of the risks and uncertainties would enable not only the implementing of this new mitigation technique as a system, but also the battling with its possibly frightful consequences.[155] As such, this strategy of mapping and managing of risks and uncertainties would help expand the underground for re-engineering.

[155] As Charles Perrow argues in *Normal Accidents,* unfixed technologies involve high risk in their use. And yet, Perrow points out, the process of building a system, and thereby fixating a particular technology, is not necessarily a way of eliminating these risks. Instead, system building may inherently increase risks for the users, operators, bystanders of the system, and the future generations. Marwan's words argued against this perspective. Perrow, Charles. 1984. *Normal accidents: living with high-risk technologies*. New York: Basic Books.

The multiple risks and uncertainties regarding CCS technology and policy, often referred to as merely technical problems that awaited resolving, may be considered metonymical expressions of a much larger project that was at play during the preparations of the modalities and procedures submission in Abu Dhabi. Here, environmental consultants, engineers and scientists continuously tinkered with a possible redefinition of climate change as a commercially viable business. After all, they were responsible for facilitating business models to compete in the global fossil fuel economy in ways that may contribute to resolving social and environmental challenges. According to many of them, climate change had to become redefined in commercial terms to constitute a plausible topic of interest.

In producing a commercially viable climate change mitigation tool for the fossil fuel economy, the participants also disclosed their personal rifts, and tried to make sense of potential contradictions and inconsistencies. "You must know," Anand, an environmental consultant at Masdar, highlighted in starting to put together the submission document, "first thing is that any project should make money. No one will do something eco-friendly and have loss. Profits may be a little lesser but loss cannot be tolerated." In this way, he implied the impossibility of discussing ecological problems independently of commercial valuation. Similarly, when I asked him about the possible motivations for working within the emergent green economy during a long taxi ride from Abu Dhabi proper to Masdar, a senior consultant to DECC at the Ministry of Foreign Affairs responded, "The environment is after all a sexy part of the

economy." Green businesses were going to expand. Drawing upon his working experience in multiple countries around the world, he added, "and not many of the environmental consultants would self-identify as environmentalists." Still, for many participants the development of the modalities and procedures submission served as an exercise in bringing together two moral domains that may not be immediately compatible with each other, an exercise that may never be adequately concluded.

This reconciliation process was perhaps most apparent, because the UAE is an oil producing country. When implementing CCS technologies, oil producing countries are able to use maturing oilfields as storage locations for the carbon dioxide that they obtain from industrial compounds, as these oilfields may be considered naturally sealed reserves. However, injecting gas into oil reservoirs leads to increased oil production as well, a process commonly known in the industry as enhanced oil recovery (EOR). By injecting carbon dioxide into ageing fields and pumping oil out, oil producers may increase the lifetime of the fields by up to 30 percent, while freeing up the natural gas more commonly used in such processes. The inclusion of CCS as an eligible technology for decreasing carbon emissions then becomes a perverse incentive for further oil production. The entities that earn most carbon credits from CCS activities in turn become oil-producing countries.

For many oil producers, including the UAE, it was important that CCS-EOR become recognized as a climate change mitigation strategy, especially because of its

immediate applicability and eventual financial gains.[156] During a meeting with representatives from DECC at the Ministry of Foreign Affairs, some consultants suggested that the UAE's oilfields are still too young, and therefore would only require EOR in thirty to forty years time. When the representative from DECC at the Ministry of Foreign Affairs, who would be participating in the next United Nations climate summit, asked how far he should push for EOR during the meeting, "Yes EOR is significant for us," one consultant summarized, "but we would like CCS to be approved as a climate change mitigation technique, even if EOR is not approved." Another consultant continued, "We need policy to pay for the environmental premium that we invest in this new technology, we are not looking for a cash cow here." They discussed a potential workshop, wherein experts from Association of Small Island States (AOSIS), at the time a major opponent to CCS as a climate change mitigation strategy, would be invited to the UAE, or maybe to Norway, to show how CCS functions on the ground. "Bring them, and convince them here," one representative from DECC announced. In the meantime, Masdar Carbon publicized plans to capture 800,000 tons of carbon dioxide from Emirates Steel's plant in the Mussafah industrial zone, and transport it through a 500 km pipeline to Abu Dhabi's oilfields by the end of 2012. Later, during a lunch break, Ravi, who has been working

[156] In addition to oil producers, technology developers, such as Japan's Mitsubishi, promoted the inclusion of CCS-EOR as a mitigation strategy. I will not engage more with this point here, but would like to suggest that these technology developers were perceived to be largely responsible for the positions that their governments held in the negotiations with the UNFCCC.

as a consultant for almost seven years confessed, "Personally, I am against CCS-EOR. But as a consultant, I will do everything to make it approved."

Emergent technoscientific projects generate new subjectivities and new moral dilemmas for the individuals that strive to research, develop or implement them.[157] Here, Ravi attempted to resolve his moral dilemmas by constructing multiple, at times divergent, selves, thereby preventing his personal goals or values from counteracting with his professional commitments. As Marilyn Strathern[158] would suggest, "the switch or transformation between perspectives [came] from the deliberate creation of alternating effectiveness," wherein his relationships to EOR relied upon varying processes of reasoning. He did not think that EOR projects had to receive carbon credits, or any further encouragement from policy-making institutions, as they already generated additional amounts of fossil fuels and thereby profits. But in the end, climate change policy was too extensive of an issue for him to effectively influence. He added that his presence or absence in the debates would not change the outcome, as they could easily find someone else to do his job. "Climate change is a business opportunity," he concluded, "We should try to come to terms with that."

[157] See Fischer, Michael. 2003. *Emergent Forms of Life and the Anthropological Voice.* Durham: Duke University Press.
[158] Strathern, Marilyn. 1997. "Double Standards" in Howell, S. *The ethnography of moralities.* London: Routledge, p. 87.

**Managing the Risks**

Increased oil production and consumption is not the only reason why CCS activities are considered controversial as climate change mitigation strategies. Issues such as site feasibility, high operational costs, future safety, and unresolved legal liability make CCS projects challenging to initiate, implement and operate. Besides, parties who are critical of CCS projects often suggest that CCS may incur a crowding out effect, leading investment away from other climate change mitigation strategies, such as renewable energy or energy efficiency projects.

In exemplifying their problems with such existing risks and uncertainties, policy consultants at Masdar would pose a wide range of questions. "What if we pump carbon dioxide into the ground here and it comes out of Iran," one of them asked during a preparatory in-house meeting, emphasizing the urgency of international legal protocols for resolving liability issues. "What if there is seismic activity due to CCS? Who will be responsible for it in 10,000 years time? Who will be responsible for it if nation states disappear," another consultant brought up, pointing to the deep futurity of current geo-engineering projects. They spoke about how models on storing nuclear waste could help in planning for carbon dioxide storage. They also spoke about producing new insurance mechanisms that involve new safety funds. Still the indeterminate spatial and temporal boundaries of CCS made it challenging for consultants to conceptualize and attend to the safety and liability issues associated with upcoming projects.

Studying the negotiations for an international legal instrument at a global United Nations (UN) conference, Annelise Riles[159] suggests, "The 20th-century problem of international institutions has been one of how to grasp [the global, national and the regional] levels, at one and the same time, how to bring them into a single encompassing view." However, the "levels" problem that Riles identifies did not emerge as a question for the policy consultants at Masdar initially, either during preparatory in-house meetings or in meetings with the Ministry of Foreign Affairs. Yet the intrinsic characteristics of CCS technologies introduced other shifting levels to their debates. The consultants at Masdar thereby addressed questions not only about nation-states, but also about their potential disappearance. They highlighted the arbitrariness of borders, in addition to their transitory nature. They showed that the present, as manageable as it may seem, was not strong enough of a temporal unit to work with. In this sense, the document preparation process disclosed and buttressed the precariousness of the categories that international institutions simultaneously relied upon and reproduced, consistently demanding an imagination of alternative futures.

And yet these alternative future scenarios had to be "translated" into the document as it was being composed, and formulized according to the thinking that the consultants could presently afford. The consultants had spoken about the

[159] Riles, Annelise. 2000. *The Network Inside Out.* Ann Arbor: University of Michigan Press, p. 91

possible disappearance of nation-states during their discussions, but when they put down their liability scheme on paper, it did not directly address the possibility of a world without nation-states. Instead, it explained that project proponents would remain liable during the short lifetime of the CCS project, but since the lifetime of underground carbon dioxide was much longer than the lifetime of a CCS project, project proponents would later transfer the liability "to an authorized body designated by the host country after the end of their short term liability period." The financial provision, which the project proponent would provide, had to cover this long-term liability period, and had to "be based on a long term probabilistic risk assessment, to be approved by the local authorities as per agreed international rules."[160] In short, the submission document simultaneously pushed the consultants to think about wide temporal and spatial scales, and locked them within the boundaries of the present.

At another instance, the consultants focused specifically on transboundary projects, and engaged in brainstorming about potential liability schemes, mostly by thinking through bilateral agreement methodologies. They wondered how the situation could be managed if several storage projects were conducted in the same reservoir, or if the reservoir stretched beyond more than one area of jurisdiction. "It may make sense to initially limit to single projects," they suggested, meaning that a storage site would have to be fully included within the territory of a single nation-

[160] Later in the negotiations this provision would continue to be controversial, as government representatives would be reluctant to take over liability for carbon dioxide.

state. Later, they enunciated the various impossibilities of their protocol. Someone incisively asked, "How do you *know* whether a project will have transboundary impact?" Finally, when putting their thoughts on paper, the consultants simply concluded, "We should have a requirement for upfront liability agreements."

On the other hand, reservoir engineers, geologists and geophysicists who participated in later meetings for preparing the modalities and procedures guidelines submission proposed a solution for these problems right away. "I don't like documents which are only buzzwords, that don't have any meat," Shahab, who worked as an executive at Abu Dhabi Company for Onshore Oil (ADCO), exclaimed upon reading the submission draft. "We should give more details about the local setting, which we know very well, only then can we produce satisfactory risk matrices." But Anand, who led the Masdar team of consultants, reacted quickly, and argued that they strove for a floating language, rather than a fixed one. The floating language that he entailed would be elastic enough to contain global histories and geographies, while retaining its meaning at a much smaller scale. Its vagueness would be its strength.

At the same time, another policy consultant tried to explain that the document had to be generic, and applicable to all countries that are part of the Kyoto Protocol. But Shahab protested, "but then how are we going to account for the differences

between carbonate oil wells in the UAE and sandstone oil wells in Europe?[161] How will we account for the difference? Where is there anything that shows this will be stringent or robust?" Shahab insisted that the submission include more details. In the meantime, Anand encouraged him to study the issues from a more macro perspective, and grew exhausted. "This is all about negotiation – what is our approach, what are our tactics? We need to state what we want without being apologetic. Descriptive words will make a reasonable submission. Make references to all tools, but make no commitments," he summarized, "Think that you are sitting in the UN and developing guidelines for the globe." While the consultants took the shifts between the local, the global and the regional for granted, it proved very difficult for them to communicate these necessary "levels" to their ADCO and ADNOC counterparts. "High level phrases, and not details – that's what you want?" Shahab confirmed before he left.

[161] Here, the chemical behavior and porosity and permeability levels of carbonate and sandstone rock formations are argued to be different from each other, which may require differing levels of risk and uncertainty as well as customized monitoring criteria. For more information on the differences between two types of reservoirs, please see: Ehrenberg, S. N., and P. H. Nadeau. 2005. "Sandstone vs. carbonate petroleum reservoirs: A global perspective on porosity-depth and porosity-permeability relationships". *AAPG Bulletin.* 89 (4): 435-445.

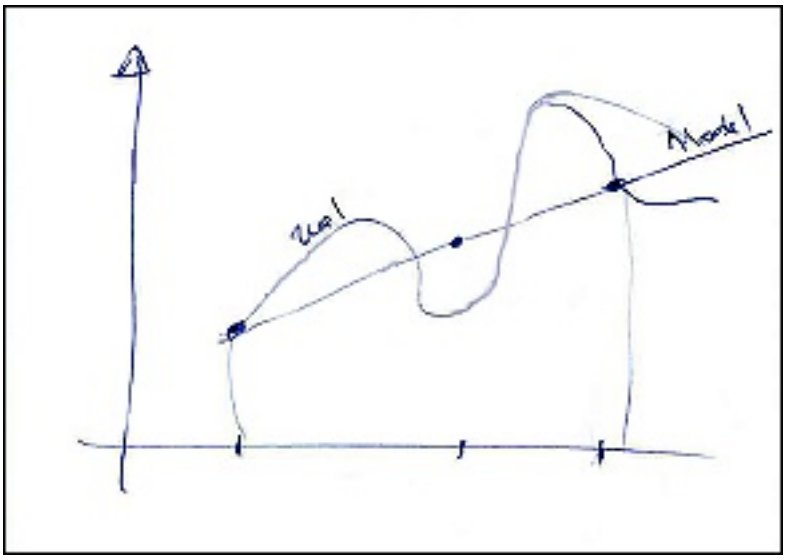


Figure 18 Real vs. Model Graph

Some weeks later, Marwan, who had participated in the preparatory meetings, noted, "The subsurface is a black box," and drew a graph in my notebook to communicate the impossibility of representing or knowing earth's geology (see Figure 2). The graph, with unidentified x or y-axes, indicated that when attempting to represent the underground the steady "model" and the wobbly "real" intersected only briefly, in this case at four specific points. He explained that the representation efforts that mostly took the shape of models were loaded with assumptions, thereby not being able to accurately reveal the real. A belief in this ultimate unrepresentability or unknowability, conveniently contained within this drawing, had perhaps made it easier for the consultants to switch levels and contexts between, let's say, carbonate wells in the UAE and sandstone wells in Europe, without fully disputing the physical

qualities that they manipulated. As such, for the consultants, uncertainty and risk remained constitutive of policy-making efforts on CCS. They suggested that they needed to act like attorneys, and defend the submission as if it is a legal case.[162]

As Timothy Luke[163] states, moral dilemmas and obligations are ascribed clearly demarcated niches within technical, managerial and organizational sets of problems and solutions that define how ecological challenges should be handled today. Accordingly, the legal metaphor that the consultants used allowed them to legitimately distance themselves from this task, and enabled them to feel less responsible for any potential implication their claims or decisions may have. Their brainstorming sessions, which spurred unknowable variables, had mostly been left out of the submission document. When defending the document as if it is a legal case, the consultants knew and accepted that it included many unanswerable questions, but still strived to produce "degrees of acceptable risk" regarding future CCS projects. The strategies of risk management constituted their main tools for manufacturing such effect.

Later, at the headquarters of ADCO, a simulation expert working on dynamic models argued, "It is not only oil that comes out of the reservoirs. We are also digging

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[162] Timothy Choy also reports a similar moment stating: "An environmental consultant based in Hong Kong drew a provocative analogy to describe his role: We're just like lawyers, only with science. A client hires you, and you argue their case. But we use science rather than the law." See Choy, Timothy. 2011. *Ecologies of comparison: an ethnography of endangerment in Hong Kong.* Durham: Duke University Press. p. 84

[163] Luke Timothy. 1995. "On Environmentality: Geo-Power and Eco-Knowledge in the Discourses of Contemporary Environmentalism." *Cultural Critique* 31: 57-81.

for information about the subsurface." He was seated across a large computer monitor where he manipulated the data that had been collected since 1973, when the first large-scale drilling operations started in Abu Dhabi. He switched from one year to another, changed reservoir pressures, zoomed deeper, seven kilometers below ground. Finally, when he was convinced with the aesthetics of the resulting image, colored in bright pinks and greens, he pressed print, and handed me the sheet (see Figure 3). Someone else in the office later commented, "The subsurface is not a black box."

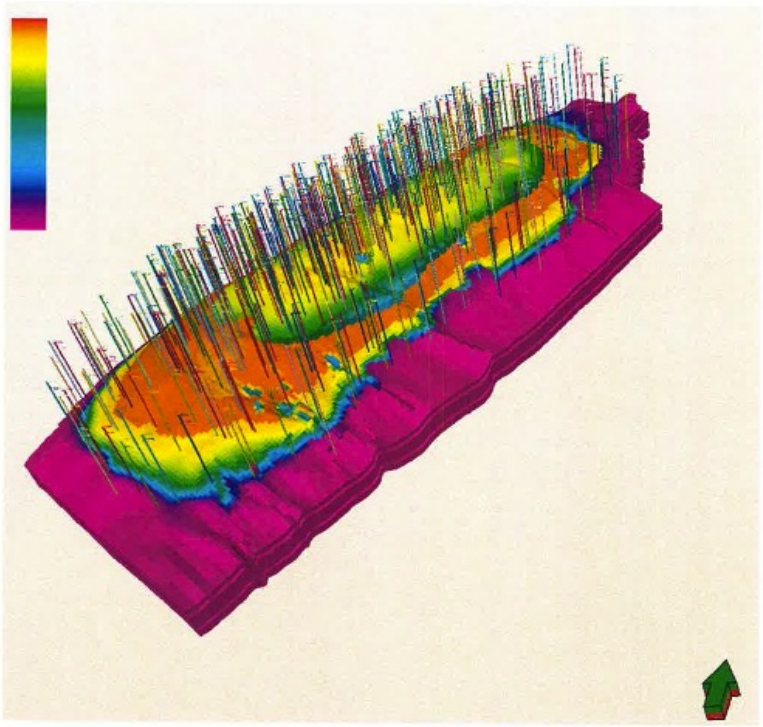

Figure 19 Subsurface Simulation Model

Embellished with injectors and extractors that resemble spikes, this colorful model represented pressure levels in a particular depth, at a certain moment in the underground. In further exploring the nature of geophysical studies, the space and time specific nature of the model would prove to be significant. For instance, Bowker,[164] elaborating on how industrial geophysics was practiced during Schlumberger's initial years,[165] states, "There was never a perfect fit between figure and ground, and "general" results were highly particular, rooted to a single site." In this way, he claims that geophysics was similar to medicine, the science of the particular, which derives its data and treatment techniques from individual cases.

This perception of geophysics as "the science of the particular" may make it somewhat easier to understand the problems that Marwan or Anand suffered from in their relationship with the scientists and engineers at ADNOC and ADCO. While the scientists and engineers believed they would be more successful in attending to individual cases, and pushed the consultants to include case specific data in the submission document, the consultants refused such contributions, dictating a global thinking. But the geophysical research methodologies perhaps did not allow for the floating language that the consultants demanded, thus triggering an inevitable

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[164] Bowker, Geoffrey. 1994. *Science on the Run: Information Management and Industrial Geophysics at Schlumberger, 1920-1940*. Cambridge: MIT Press, p. 32-33. Also see, Mitchell, Timothy. 2011. *Carbon Democracy*. New York: Verso, p. 243-244.

[165] Founded by Schlumberger brothers in France in 1926, Schlumberger is the world's largest oilfield services company. Currently, it operates in about 85 countries, and supplies the oil industry with services regarding the subsurface, in the forms of seismic evaluations, well testing or well cementing.

disagreement between the two parties. As such, geophysics unveiled how "the subsurface is *not* a black box" for particular instances, but when it tried to produce more generalizable models, it perhaps did fail, reflecting what Marwan called the "real" in only a few instances. The discussion between Anand and Shahab had in fact exposed a pertinent disciplinary characteristic, which possibly made it challenging for the scientists to switch "levels." Accordingly, the discussions regarding the "levels" and "the subsurface as a black box" called attention to the difficulties of the transition from the particular to the general or vice versa, in different manners. The two knowledges perhaps utilized different means of abstraction in creating the link between the particular and global levels.

The reservoir engineers and geologists at ADCO claimed an ever-improving knowledge of the subsurface, and evidenced multiple research techniques. Static and dynamic models, in addition to seismic and sonar testing were crucial in reproducing the underground. They did not have any predictive models at hand, but by relying on a combination of computer modeling and "real-world" monitoring, they would excel at CCS technology. "But it is all about the imagination at the end," Aref, a reservoir engineer at Abu Dhabi National Oil Company (ADNOC), suggested, and explained how they organize field trips to Jebel Hafeet (see Figure 4), the UAE's most well-known mountain with a 1249 meters peak, in order to expose the earth's geology to students and junior engineers. "We explain that there are infinite layers, like the layers

you see on the mountain, inside the earth," he continued. The students and junior engineers were thus expected to observe the mountain, and extrapolate.

Figure 20 Jebel Hafeet

The imagination work that the engineers attempted, however, was rather different from the brainstorming sessions at Masdar. Aref stated that such a geological field trip could at times be unnecessary. To understand an oilfield, it could prove to be enough to simply observe a child sipping a drink by using a straw. What mattered most was to understand simple mechanics that could be applied in other contexts. The engineers at ADNOC and ADCO took these infrastructures for granted, in a way that the consultants at Masdar could not. Both parties sought

applicability and transferability of conditions. But while the consultants addressed a possible transformation of sociopolitical contexts, albeit temporarily, the engineers and scientists relied on the seeming stability of the earth's crust, and its associated mechanics.

Having occupied various positions in the petroleum industry for more than a decade, Aref had had the opportunity to work with optimum field development plans, which are designed using subsurface static and dynamic models. A week after our meeting, during an email exchange, he suggested that these tools were still quite limited, but that they were progressing very fast. "If we focus on the task of collecting all relevant data and building the right tools to model the global climate phenomena, we will be able to play a few global weather forecast scenarios assuming different levels of human activity. Only then, we should be able to seriously think about deliberate manipulation of planetary environment," he concluded. Did the engineers then believe that the planet is not yet ready for policy-making regarding geo-engineering projects, such as CCS? An executive from ADCO asked, "How could you generate policy without proof of concepts? We may be ignoring the key risks."

The trouble must have been about differing conceptions of risk and uncertainty. Many consultants believed that they had to complete the submission, in a way that matches or even exceeds expectations, regardless of what may lie ahead in terms of CCS or EOR research. On the other hand, the reservoir engineers and

geologists attempted to localize the risks and uncertainties, and produce as much quantitative feedback as they could, which would not be directly useful for other contexts. A week before February 21st 2011, when the consultants were finally delivering the 36-page document to the UAE leadership in order to request final approval, the document had mostly been cleansed of numbers and graphs that described the local context. And yet it included sample uncertainty matrices (see Figure 5 below), which had been used for pilot projects in the UAE.[166]

[166] The final submission document entitled "Submission of views from the United Arab Emirates on addressing the issues referred to in paragraph 3 of FCCC/CMP/2010/L.10 in the modalities and procedures for the inclusion of carbon dioxide capture and storage (CCS) in geological formations as clean development mechanism project activities" is available online at *unfccc.int/files/methods.../uae_submission_on_ccs_in_cdm_20110221.pdf* Last accessed September 8, 2011

| Categories | Sub-Categories | Elements | Rumailta Zone B | | Al Dabb'iya Zone B | | Al Dabb'iya TZ B | | Bab Far North | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Complexity | Uncertainty | Complexity | Uncertainty | Complexity | Uncertainty | Complexity | Uncertainty |
| Subsurface | Reservoir Properties | Horizontal Permeability Heterogeneity | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 |
| | | Vertical Permeability Heterogeneity | 4 | 5 | 4 | 4 | 4 | 4 | 3 | 4 |
| | | Stylolite Presence and Development | 4 | 2 | 3 | 3 | 3 | 3 | 2 | 2 |
| | | Reservoir Pay Thickness | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | | Reservoir Quality (RRT) | 4 | 3 | 3 | 4 | 3 | 4 | 2 | 2 |
| | Reservoir Structure & Gelogy | Structural Compartmentalization | 4 | 4 | 4 | 3 | 3 | 3 | 5 | 5 |
| | | Faulting and Natural Fractures | 5 | 4 | 4 | 3 | 3 | 3 | 4 | 4 |
| | | Reservoir Dip | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 |
| | Reservoir Rock and Fluid Properties | Oil Properties | 3 | 3 | 3 | 4 | 2 | 4 | 5 | 5 |
| | | EOR Injected Gas/Oil PVT | 4 | 3 | 4 | 3 | 4 | 3 | 5 | 4 |
| | | EOR Injected Gas/Oil EOS | 4 | 2 | 3 | 3 | 3 | 3 | 5 | 4 |
| | | EOR Injected Gas/Oil MMP | 5 | 4 | 4 | 4 | 4 | 4 | 5 | 4 |
| | | Waxes/Asphaltene Oil & with Inj Gas | 4 | 4 | 3 | 4 | 3 | 4 | 4 | 3 |
| | | Mechanical Property & Mineralogy | 4 | 4 | 3 | 3 | 3 | 3 | 2 | 2 |
| | | Routine and Special Core Analysis | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 |
| | | Gas Misc/Imm Sec. & Ter Corefloods | 4 | 4 | 4 | 4 | 3 | 3 | 4 | 4 |
| Surface | Reservoir Development | Current Development Stage | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 2 |
| | | Current Development Mechanism | 4 | 4 | 3 | 3 | 3 | 3 | N/A | N/A |
| | | EOR Gas (e.g., CO2) Source and Supply | N/A | N/A | 3 | 3 | 3 | 3 | 5 | 4 |
| | | Subsurface Infrastructure | 4 | 4 | 4 | 4 | 3 | 3 | N/A | N/A |
| | Drilling, Facilities and HSE | HSSE | 4 | 4 | 3 | 4 | 3 | 3 | 1 | 4 |
| | | Injectio/Production facilities | 5 | 3 | 3 | 4 | 3 | 4 | 5 | 5 |
| | | Gas Separation facilities | 5 | 3 | 3 | 4 | 3 | 4 | 5 | 5 |
| | | Facilities CO2/H2S handling Capability | 5 | 3 | 5 | 4 | 4 | 4 | 5 | 5 |
| | | Facilities CO2/H2S Injection capability | 5 | 3 | 5 | 3 | 4 | 4 | 5 | 5 |
| | | CO2/H2S Breakthrough and Cycling | 5 | 2 | 5 | 2 | 4 | 4 | 5 | 5 |
| | | Integrity Management (Corrosion) | 5 | 3 | 5 | 3 | 4 | 4 | 4 | 4 |
| Others | EOR Related Project Objectives Uncertainties | Displacement Efficiency | | 4 | | 3 | | 3 | | 3 |
| | | Vertical Sweep Efficiency | | 4 | | 3 | | 3 | | 2 |
| | | Areal Sweep Efficiency | | 3 | | 3 | | 3 | | 2 |
| | | Recovery factor | | 4 | | 3 | | 3 | | 3 |
| | | CO2 Purity | | 4 | | 4 | | 4 | | N/A |
| | | MMP Condition / Reservoir Pressure | | 5 | | 3 | | 3 | | 5 |
| | | Reservoir Property Alteration | | 5 | | 3 | | 3 | | 4 |
| | | Asphaltene Precipitation | | 4 | | 2 | | 2 | | 2 |
| | | Injectivity | | 5 | | 3 | | 3 | | 3 |
| | | Well Design | | 5 | | 3 | | 3 | | 4 |
| | | WAG Benefit | | 4 | | 3 | | 3 | | 2 |
| | | Injection/Production Rates Optimization | | 4 | | 3 | | 3 | | 2 |
| | | Monitoring/Surveillance Plan Design | | 4 | | 3 | | 3 | | 2 |
| | | | 4.125 | 3.6875 | 3.6875 | 3.625 | 3.25 | 3.4375 | 3.875 | 3.6875 |

*Table 1. Complexity and uncertainty matrix used in Abu Dhabi Company for Onshore Operations (ADCO) CCUS project screening (all facts and figures in the following figure are non representative and for demonstration purposes only).*

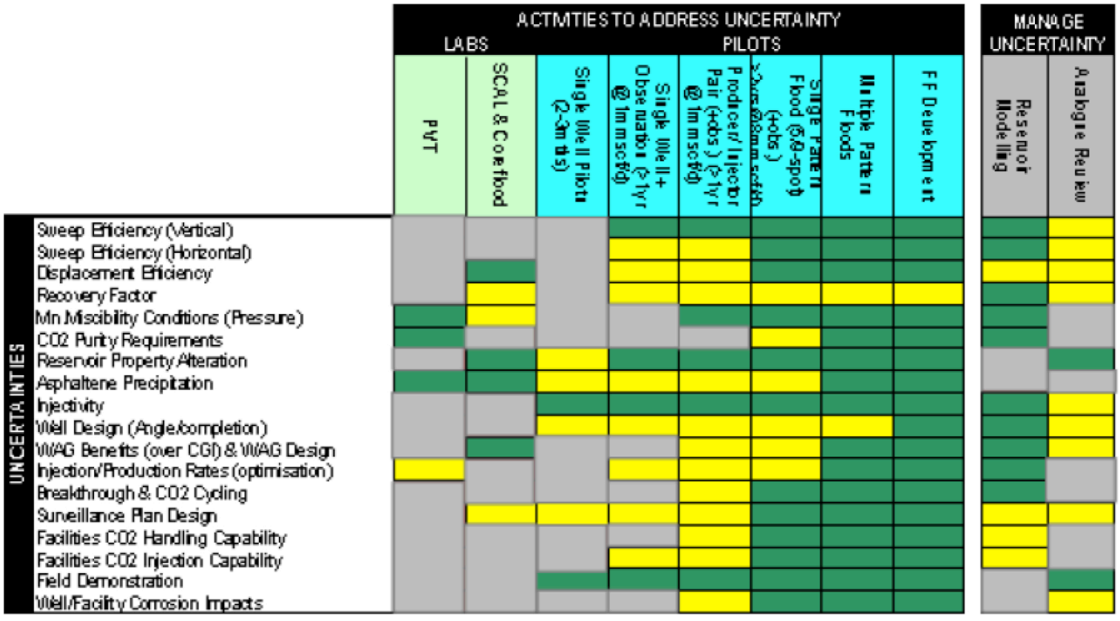


*Table 2. List of key $CO_2$ CCUS related uncertainties and mitigations considered for Abu Dhabi CCUS project*

Figure 21 Uncertainty Matrices

The uncertainty matrices had been provided as clear evidence for the manageability of CCS projects. The introductory text thereby suggested: "Uncertainty can be analyzed and quantified, and if managed properly, reservoir development and risk mitigation can be improved as a result. Consequently, reservoir management, CO2 injection, process physics, chemistry and ultimately modeling is essential to developing a risk assessment matrix correlated with a mitigation plan (see Table 2 below)." But such manageability would only come at a cost: "Significant capital expenditure and manpower are required to conduct these highly technical and state-of-the-art studies to address uncertainties as described below (conducted by Abu Dhabi National Oil Company)," the final submission document suggested. The adequacy of capital expenditure and manpower would be evaluated on a project basis. The uncertainty matrices served as crisp indicators of a certainty that remained out of reach.

How does one understand the relationship between the different ways of imagining earth – either as a temporary sociopolitical space, or as a solid geology – and the different ways of perceiving risk and uncertainty? In trying to create the modalities and procedures guidelines submission, the consultants knew and repeatedly admitted that they dwelled a risky and uncertain earth. Nevertheless, they tried to conjure a possibility of certainty, charted in vague, floating sentences or uncertainty matrices. In a way, they utilized this document as a means of restraining their imaginations, thereby creating stability. On the other hand, the engineers and

scientists, who were present in the debates, thought that their imaginations already gave way to a level of certainty, especially at a particular, case-by-case basis. As such, the charts were only a means of representing the stability that they had access to by observing the earth's dynamics – during a mountain excursion, or while watching a child sipping drinks.

A few days later, in responding to the ADNOC and ADCO engineers and geologists, Anand reiterated, "You cannot reach a destination when you have no road." As indeterminate as they were, the policy-making efforts were more than valid, because they would eventually enable engineers and scientists to work towards the betterment of climate change mitigation technologies. They would serve as infrastructure, more than anything, and pay for the environmental premium that governments and corporations are expected to invest. Anand could not understand what it was exactly that the scientists and engineers misconceived. "And there are other examples of CCS projects in the world," Anand said, and like many others in the office, referred to Algeria's In Salah (Ain Salah, in other transliterations) project.

**The In Salah CCS Project**

The In Salah carbon capture and storage project, in operation since August 2004, is a joint venture between BP, StatoilHydro and Sonatrach, the Algerian

government-owned oil and gas company.[167] Marwan, who had previously worked for an Algerian ministry thereby being loosely associated with the project, quickly became a spokesperson on matters related to Algeria's energy and climate change mitigation policy. "This is the biggest onshore CCS project in the world. Its large scale helps people understand that it can be done," he stated during an interview in a spare meeting room. The large scale of the project had been possible due to a specific legal regulation in Algeria, which allowed the national oil company to enter joint ventures. Marwan explained that the site had been selected especially because of its capacities as a gas reservoir. The gas extracted on-site contained high quantities of carbon dioxide, which had to be removed before it was piped, as it would otherwise corrode the pipes. Therefore, the project proponents had indicated that it would be most convenient if the retrieved carbon dioxide were to be re-injected into maturing reservoirs. The construction phase for In Salah, wherein Sonatrach, the national oil company, had a 35 per cent share, while BP and Statoil respectively owned 33 and 32 per cent, started in 2001, mainly as a learning exercise for storing carbon dioxide.

"It was a good idea for BP and Statoil," Marwan then stated, "They may need to learn to store carbon dioxide because of the Kyoto Protocol. When they have caps

[167] Other participants to the project are Lawrence Livermore National Laboratory, Lawrence Berkeley National Laboratory, Institut Francaise du Petrole, European Commission, US Department of Energy (DOE), Carbon Sequestration Leadership Forum (CSLF) and CO2ReMoVe. For an analysis of the project, conducted by Lawrence Livermore National Laboratory, please see: Friedmann, S J. 2006. *The scientific case for large CO2 storage projects worldwide Where they should go, what they should look like, and how much they should cost*. Washington, D.C.: United States. Dept. of Energy.

on their emissions, they will be obliged to store carbon dioxide in their own countries. So they used In Salah as an experiment with carbon dioxide." But what about Sonatrach? "Sonatrach had no financial incentive or obligation to do this," the consultant initially expressed, and later reflected on the inherent inequalities within the project. "Minister of Energy at the time decided to go ahead with the project, mainly on his own…So he just handed in 35 million dollars, without any obligations…If Sonatrach goes to the North Sea to produce oil there, due to emission limitations, it will be helpful for them to have this experience. But this never happens. I'd say that there is less than 1% probability that Sonatrach will work in the developed world. And there is so much that needs to be done in Algeria, in terms of environmental protection, before starting to invest in CCS projects. Treat wastewater! Treat hazardous wastes! The company is not even compliant with regulations at a basic level. But they went on to explore," he complained.

By referring to a case outside the UAE, Marwan actually showed how the macro level arguments that they strived to put down on paper were not always so constructive. While the policy proposal that they produced would comfortably treat the In Salah case as being equivalent to a potential CCS project in the UAE, as someone who had experience with both contexts, Marwan knew that they were drastically different, and sparked off divergent problems and questions. As he further explicated the In Salah case, he put forth these differences more clearly.

The three partners that cooperated for the In Salah project had brought in technology developers and created a monitoring fund, with the main objective of understanding whether the re-injected carbon dioxide remains in place, thereby studying the seepage and leakage behavior of the storage formation. They implemented tracers that tracked the movement of carbon dioxide underground, which generated further value for the experiment. Still, Marwan insisted that if Sonatrach wanted to save the environment,[168] this was the last thing to do. According to him, Sonatrach initially had to attend to problems such as toxic waste, environmental impact of facilities or leaking oil pipelines. Money spent on this project would be better spent on other things. After a brief pause, he added, "But for Abu Dhabi (which is also considered a developing country according to the UNFCCC standards) it is different, here there is enhanced oil recovery (EOR)…So all I'm saying is, Algeria is getting no benefit out of this, why should it pay for the errors of others, like the United States? Developing countries should initially cling on to their own priorities, others should take care of the damage that they have done to the environment for so many years." In the transformation of climate change into a commercially viable frontier not every party had the same function or responsibility.

[168] During my fieldwork, my interlocutors comfortably used phrases such as "saving the environment" or being "good for the environment." Although it is necessary to deconstruct what they understood by these phrases, or what the circulation of these phrases implies for larger issues around climate change mitigation, I will not engage with these problems in the scope of this chapter.

**Oil Companies in the UAE**

While multinational oil companies had pushed for CCS efforts in Algeria, they took a rather different stance towards the utilization of carbon dioxide in the UAE. BP, Shell and ExxonMobil which have a 40% share in ADCO, had initially been resistant to research on CCS or EOR. "We needed 80% to make a decision, so we could not proceed before convincing them that it is a good idea," said one executive at ADNOC, the national oil company, and 60% shareholder at ADCO. Masdar had been a catalyst for pilot projects on CCS, and had argued that ADNOC could make use of carbon dioxide in a way that will add value for oil. First, the oil reservoirs had to be designed in a way that would work better with carbon dioxide. Then ADNOC needed to learn how to work with carbon dioxide in the subsurface. "We regularly use an air separation unit and retrieve nitrogen for gas operations, but we do not have the same infrastructure for carbon dioxide," the ADNOC executive continued. Implementing this infrastructure would serve three main goals. "First it is good for the environment," he plainly stated, "second it is good for the image of Abu Dhabi, and third, of course, there is EOR." In twenty to thirty years, it would be necessary to use another injectant to retrieve more oil. "That's how we started doing an earlier assessment of carbon dioxide," he added.

Initially ADNOC had problems with BP, Shell and ExxonMobil. "Since they didn't want to invest money," he explained, "they were using technical reasons to kill the project." But then ADNOC insisted that they don't want politics or economics to

take over the discussion, "just give us your expertise," they protested. Still, BP, Shell and ExxonMobil tried to convince the Abu Dhabi authorities that they did not need carbon dioxide here. Their reservoirs were very rich. "In the end, we said carbon dioxide will increase oil production and will release hydrocarbon gas. We started two offshore studies, only conceptually. We finally agreed."

The ADNOC executive's words were surprising, especially given the professional environment in which oil companies continuously seem to foster CCS practices worldwide. At the World Future Energy Summit (WFES) in Abu Dhabi in January 2011, for instance, executives from ExxonMobil organized a meeting, in which they informed participants of how they perceive the future of CCS. They strictly argued that CCS constitutes 20% of the solution towards meeting the 3-degree abatement target, set by the Kyoto Protocol. For them, CCS was not *the* solution, but it was a major part of the solution. "Half of this has nothing to do with the power industry," the ExxonMobil spokesperson suggested, "sectors like steel, cement, fertilizers, and gas processing also have to invest in CCS projects." They expected that there would be at least a hundred large-scale CCS projects around the world in 2020, and that more than half of those projects would be located in non-OECD countries, such as China and India. "We're going to look at fairly significant financial flows here," he said. And that's why CCS had to be economically justified. But during the question and answer session, he gave the green light for profitmaking. "Currently, the bulk of [CCS] projects are EOR projects in the United States, and clearly there are

no drivers except for profitmaking. So they are profitable. They are using carbon dioxide for EOR, and at $80 a barrel of oil, there is money to be made." Then again, the executive continued, "The only reason for doing CCS is climate change, there is no other reason than that." The deployment and commercialization of the technology was perceived to be the most challenging for CCS projects.

It is important to examine the ways in which CCS operations are understood and acted out by multinational oil companies, not only because the oil industry has the most experience with CCS projects due to EOR, but also because multinational oil companies are heavily involved in the implementation and operation of carbon capture and storage policy. Despite their absence in the negotiations for the modalities and procedures, in the UAE as well, multinational oil companies indirectly governed the discursive field for climate change mitigation strategies. During a telephone interview, a UNFCCC employee remarked that oil companies do not attend to meetings or prepare submissions, and in this sense mostly remain absent from the debates. Instead, they choose to lobby and pressure the governments that they work with.

"Sooner or later, CCS will become an official part of climate change mitigation strategy, and the negotiations will be concluded," the UNFCCC officer continued. There was too much pressure from OPEC, especially because they wanted EOR to be approved. It was feared that oil producers would refuse to cooperate on other climate change mitigation issues, in case CCS-EOR was not endorsed as a mitigation strategy.

"Methodologically, it will not be too much of a problem to include CCS-EOR as a climate change mitigation strategy," the UNFCCC employee then stated. The issue would basically not be explicitly addressed. As Anand had suggested during the meetings with ADNOC and ADCO engineers, the vagueness of the document would be its strength.

The oil industry not only influences policy making on climate change mitigation by lobbying and pressuring governments, but it also provides labor power for the emergent renewable energy and clean technology sector. Many of the policy consultants at Masdar Carbon had been headhunted from major consulting companies, commonly referred to as the Big Four: Deloitte Touche Tohmatsu, PwC, Ernst & Young or KPMG, where they extensively dealt with operations related to the energy industry. But other participants to the preparation of the modalities and procedures guideline submission were currently working for ADCO and ADNOC, and had advanced their careers in multinational oil companies like ExxonMobil, Total or Shell. What did the heavy presence of the oil industry mean for the emergent green economy?

Acknowledging the deep connections between climate change mitigation technologies and the fossil fuel economy, Larry Lohmann[169] writes, "Most financial, corporate and government leaders will not be able to find their own way…to successful climate investment policies…Their place in society has been carved out and

[169] Lohmann, Larry. 2009. "Climate as Investment." *Development and Change* 40: 1063–1083, p. 1078

sustained by fossil fuels and fossil fuel substitutes and by the economic and political practices that most need questioning." Accordingly, he suggests, climate change policy will have to be led by a popular movement, and not the oil industry. That is why the economic crash offers the best opportunity for the economy to be transformed into "a force for livelihood and survival."

**UNFCCC**

A few months after the submission had been completed, a UNFCCC employee touched upon the potential problems with concentrated amounts of carbon dioxide as we had lunch in a Bonn restaurant. To illustrate how carbon dioxide may be dangerous, he specifically referred to an incident in Central Africa. In 1986, Lake Nyos of Cameroon had started emitting large levels of carbon dioxide, leading to large-scale asphyxiation of humans and animals in the surrounding areas.[170] The carbon dioxide that leaked from the lake had been completely natural, but was enough to showcase how fatal such outgassing could prove to be. In Canada as well, there were recorded instances of outgassing. But the Canadian officials, who have been

[170] Elaine Shanklin writes: "In the night of 21 August 1986 Lake Nyos exploded. The 'good' lake, as the locals called it, the most beautiful crater lake in Cameroon's North West Province, exploded and sent down to the valley beneath a deadly cloud of carbon dioxide that killed most of the living things it touched -1746 men, women and children, more than 3,000 cattle, plus countless numbers of sheep, goats, birds and insects. Little or no damage was done to plants, crops or inanimate property. Houses, market stalls, village ovens and motorcycles stood untouched, while their owners lay dead nearby." Shanklin, Elaine. 1988. "Beautiful Deadly Lake Nyos: The Explosion and its Aftermath" *Anthropology Today* 4(1): 12-14

experimenting with CCS for some years, did not know how much of the emissions resulted from injected carbon dioxide, and how much of it was natural. Their accounting had come to a dead-end. The UNFCCC representative then pointed out how some states (*Länder*) in Germany were now banning potential CCS projects. The International Energy Agency (IEA) report entitled "Carbon Capture and Storage: Legal and Regulatory Review"[171] also included: "CCS is still highly controversial in Germany…Additional controversy has been generated by the inclusion of an "opt-out" clause in the draft act at the insistence of certain *Länder*, whereby states can designate areas as ineligible for CCS deployment, effectively vetoing CCS in those areas." It was expected that Germany's hesitation would be annulled.

"Right now things are dismal," another UNFCCC employee briskly commented on climate change policy. According to him, the main risk regarding CCS in specific and climate change in general was about commitment and willpower issues. "The United States has its own issues to deal with, and the Republicans are hard to crack," he said. Otherwise, he believed that the UNFCCC had a clear roadmap that needed to be followed. That would be the way to resolve uncertainty and risk. "Solutions are available, and willpower will create clarity, and uncertainty will be resolved in that manner," he added, as I prepared to leave his Bonn office. By saying that, he was not playing environmentalist. He specified that he understood the profit

[171] International Energy Agency, 2011. "Carbon Capture and Storage: Legal and Regulatory Review" Available at www.iea.org/Papers/2011/ccs_legal.pdf *Last accessed September 28, 2011*

making needs of industries. "I would not take a rustic action, and propose a radical position saying close everything down," he concluded. Here, rustic action meant a move that would recall and celebrate a bucolic life, thereby working against the industry. He concluded, "Again, clarity is up to the parties."

**Depicting Climate Futures**

In this chapter, I have followed the production of the UAE's modalities and procedures guidelines submission, exploring the tracks on which it traveled to reach a particular semiotic and material existence. In this way, I attempted to draw attention to the incidental artifacts that emerged during this process. First, the unavoidable tensions between the policy consultants at Masdar and the engineers and scientists at ADNOC and ADCO served to underline the ways in which competing definitions of risk and uncertainty shape the processes of decision-making regarding climate change. These tensions, formulated here as two main discussions on "levels" and on "subsurface as a black box," not only buttressed the significance of consultants as mediators of risk management but also pointed to how "degrees of acceptable risk" become crucial in producing methodologies of mitigating climate change that are aligned with the fossil fuel economy. In the meantime, the production of the policy proposal was shadowed by the indirect presence of oil companies, which adopted inconsistent attitudes towards CCS in different contexts. Referring to cases like In

Salah enabled me to underline the specificities of each CCS project, within a context where those specificities were at times being sidelined. In the end, the UNFCCC officers, unable to provide the much-desired clarity, also passed on the responsibility for depicting climate futures.

## CONCLUSION:

### Redefining Sustainability

In a survey she conducted for a term project on sustainability and transportation,[172] Elif, a Masdar Institute student, had found that almost all the respondents, most of them from Masdar, self-identified as caring about the environment. However, in answering another critical question on the survey, which required respondents to tick a box ranging from one to five, they had created their own categories and answered zero. They would 'never' use public transportation, regardless of how 'sustainable' they understood themselves to be. Elif asked me, how could people not comprehend that these two answers are inconsistent with one another?

Elif's survey was an illustration of the tension between two domains that sought to shape and regulate everyday life within Masdar, and within the wider Abu Dhabi context. While sustainability was embraced as an abstract value, the practices associated with it were not always perceived to be practical or socially desirable. Using public transportation in the Emirates, for instance, was denigrated as a practice that only low-wage immigrant workers depended upon. The survey respondents hoped to stay away from this shunned class by suggesting that they would never use

[172] Elif informed me that one hundred people responded to the survey. 30 of these people were Emiratis, whereas the others were expatriates. Of the 100 people, 62 were male and 38 were female.

public transportation. The tension between the two domains – the attempt at acting in a 'sustainable' manner and the desire to maintain a particular social status – thus gave rise to a redefinition of sustainability, as an abstraction that need not be associated with habits such as public transit. As a result, sustainability became reframed as a performance of the idea of sustainability. Performative utterances regarding an abstraction of sustainability became divorced from practical associations with it.

At Masdar such unresolved tensions between different knowledges most often resulted in a growing accommodation of contradictions within the renewable energy and clean technology sector, most vividly illustrated by an eco-city that is surrounded by a parking lot of SUVs. In this concluding section, I would like to argue that these contradictions might perhaps comprise productive instances, wherein the indeterminacies of sustainability as a concept became exposed and materialized, rather than obscured and disregarded, and I interrogate what this finding means for the broader understandings of the concept. How could these contradictions, such as those Elif identified in her survey, contribute to sustainability debates?

By revealing indeterminacies, which are often obfuscated by abstract and rather holistic framings of sustainability at Masdar and else where, these contradictions call for a revising of global conceptions of energy and climate futures. Rather than performing a seamless sustainability, such contradictions instruct practitioners and

scholars of climate and energy futures to avoid closures, in this sense proving to remain valuable objects of analysis.

**Sustainability as an Indeterminate Concept**

"The concept of sustainable development stemmed from environmental movements in earlier decades," Dr. Nawal, the sustainability director of Masdar explains in a blog post, "International forums, such as the Earth Summit in Rio in 1992, brought sustainable development to the mainstream." She emphasizes, "Today, the concept is often over-used and it may mean different things to different people, but it clearly goes to the heart of tackling a number of inter-related global issues such as poverty, food and water resources, energy security, and environmental preservation."[173] In this way, Dr. Nawal publicly acknowledges how the meaning of sustainability remains increasingly undefined. But how did sustainability play out in the context of Masdar? And how was it performed?

During interviews and informal conversations, my interlocutors often highlighted that Masdar was "not environmentalism," meaning not a project that advocated for closing down all businesses and stopping production, or surrendering capitalist consumerism. Instead Masdar was framed as a project that targeted managing business models and technoscientific innovations, and accordingly, doing

[173] http://blog.zayedfutureenergyprize.com/?p=38 Last accessed April 6, 2012

what is feasible within the boundaries of social, political and economic resources currently available. Mazen, an executive at Masdar, argued for instance that the company attempted at a new model of "resource management." Accordingly, he insisted that Masdar did not have the capacity to change the way in which capitalism functioned, and could only operate in conjunction with the present social, political and economic circumstances.

In this framework, Anna, a faculty member at Masdar Institute commented, "resource management" implied the production of another direction towards which Abu Dhabi's economy would be steered. According to her, the idea of resource management that Mazen outlined was about making sure that the country would have enough resources in the future, when it runs out of abundant fossil fuels. Masdar, in this sense, was not environmentalism. Instead, it constituted a renewable 'source' for the growth of a knowledge-based economy, and facilitated the transformation of oil-based relations into knowledge-based ones.

In comprising a source for the knowledge-based economy, however, Masdar heavily relied upon representations of iconic renewable energy and clean technology infrastructures. It was clear to my interlocutors that a theatrical performance of these emergent sustainable infrastructures constituted the heart of Masdar's capacity to forge relations, giving rise to a particular relationality, at times of commercial significance. At Masdar, the practice of sustainability thereby became equivalent with the practice of producing a repeated performance of a business-friendly and

technology-driven sustainability, exemplified by personal rapid transit rides between the parking lot and the Masdar Institute campus. The performativities of the projects under construction were able to induce the formation of collectivities around themselves. Accordingly, the incompletion, disintegration and failure of the projects at times remained secondary to their performative appearances.

And yet it is important to note that conceptions of incompletion, disintegration and failure regarding the projects at hand were not always shared at Masdar. Different participants, such as students, on-site architects, or subcontractors from various trades, brought in their own expectations regarding the projects, perhaps attesting to how the projects did not necessarily cultivate a homogenous definition or vision of sustainability, but rather remained essentially fragmented. While marketing and communications campaigns, or policy-making efforts at the international scale, framed Masdar as one integral object, which promised to produce unified, at times totalizing, solutions for problems regarding energy deficiency and climate change, at the personal level, this perception was regularly challenged.

Despite seeking to instigate relations and collectivities through emergent artifacts, the business-friendly and technology-driven performances of sustainability did not incorporate the underpaid immigrant labor force within its main tenets, even at the scale of abstraction. The sustainability of the manual labor, who physically built and maintained the project on an everyday basis, then became detached from the sustainability ideals of the project. As one on-site architect emphasized, at Masdar

sustainability was not about human capital, justice or equality. Instead, it often required and depended upon an elimination of these concepts for its success.

And yet some of my interlocutors argued that this lack of attention to human capital, justice or equality had been a critical barrier for the implementation of the idea of sustainability at Masdar. "Maybe if Masdar was in another country, it would have been easier," Anna suggested, "because in Abu Dhabi there is almost no expertise in regards to green building." She emphasized how workers were not trained, or invested in the meticulous work that was required for the construction of green buildings, echoing many of the architects and engineers involved in the making of Masdar. While such repeating problems ensured the continuation of the project, regardless of potential anxieties about its future political and social configuration, they also made it more difficult for the project to embody the repeated ideals of sustainability.

Despite attempts at the level of project management towards measuring, quantifying or eloquently defining the Masdar project and its boundaries, these varying implementations of an idea of sustainability could not escape an ever-growing indeterminacy. As a result, at the personal level, the project was best articulated through the use of metaphor and metonymy, such as "spaceship in the desert," "a technocratic dictatorship," or "an expensive toy," safeguarding the meaning from decisive clarifications or closures.

I argue that these metaphors and metonymies, representing a challenge towards the holistic understandings of how sustainability should be performed, were a most inspiring aspect of the Masdar project. Rather than trying to fix, conceal, or categorize these metaphors and metonymies, perhaps future sustainability debates both inside and outside Masdar should celebrate their indeterminacy, and expose their inherent inconsistencies.

**Documenting Sustainability**

At Masdar, sustainability was defined and represented through a commitment to "trial and error," Anna explained some months after we had both left Abu Dhabi, a type of trial and error that did not claim to challenge the present social, political and economic circumstances. "And a project that is about trial and error needs documentation. That's the most important way in which we can contribute to discussions on sustainability," she emphasized, "We need to know exactly why the concept of sustainability could not be implemented at Masdar in the way it was planned, or why it was such a great challenge." Then she told me how she had been part of an initiative some years ago to document the everyday of Masdar, specifically by working with ethnographers.

Anna's proposed project had foregrounded close collaboration with anthropologists and sociologists from universities in the UAE so as to produce a

database regarding the everyday workings of the initiative. She imagined that having such a database at their disposal would facilitate self-reflection, allowing the producers of Masdar to look back and depict what had gone wrong at what stage of the project, and to possibly correct their mistakes in the future. Since someone who had direct stakes in the development of the project could not do this, she thought, they needed to bring in independent ethnographers. In this way, the project would also have global impact, she imagined, providing others with a thorough knowledge base that would clearly illustrate the potential tribulations of implementing such sustainability.

However, Anna's plan would soon malfunction, along with many other plans that dissolved in the making of Masdar. She had been able to locate two anthropologists who were interested in working at Masdar full time, but she did not know how she would secure the funding such a project required. She contacted the sustainability department for funding, elaborating her reasoning. And yet the executives did not fully agree with her understanding of such knowledge making practices. "Unfortunately," she explained, "such [anthropological] type of knowledge was argued to be too esoteric for a project like Masdar." After listening to her concerns, and claiming to understand her rationale, the sustainability department decided to hire a global management consulting company to conduct research inside Masdar for three months. This research culminated in a comprehensive report, entitled "The Masdar Experience," which concentrated on questions like who should be residing at Masdar City upon its completion.

Anna's attempt at bringing in anthropological tools to the project had backfired, and in the meantime, demonstrated the tensions between two types of knowledge within the institution. While anthropological knowledge was perceived to be marginal and commercially ineffective, the consultants' knowledge would be easily digestible and transferrable to capital, helping Masdar in its prospective strategic decision-making. Furthermore, the duration of the project had become an important concern. Anna had hoped that the anthropologists would conduct fieldwork in the company for one or two years, and be compensated accordingly. On the other hand, the consulting company promised to deliver a report in only three months, producing immediate results for the Masdar executives. At the face of such comparison, the longer ethnographic study was understood to be somewhat impractical and unnecessary. When they finished their work, however, the consulting company had managed to produce further imaginaries for Masdar to implement, rather than analyzing decision-making processes or studying potential errors. Perhaps, this was not what Anna had in mind when she approached Masdar's sustainability department with a request for detailed documentation of the project's different stages.

I did not conduct this ethnographic study with the financial or organizational means that Anna imagined to make available then, or with any awareness that such interest regarding anthropological knowledge existed within Masdar before I started my fieldwork. I lived an hour away of from the construction site, and commuted daily to Masdar thanks to the many rides that my interlocutors offered. I was

affiliated with two projects at Masdar Institute and at Masdar Carbon, as a research assistant and an intern, respectively. Through my involvement with these two projects, and due to the fact that I had two desks at two different units of Masdar, I was able to formally and informally converse with many individuals with diverse personal histories and responsibilities. These conversations form an essential basis of my ethnographic material. Since the end of my fieldwork in June of 2011, many of these people have moved on with their careers and their private lives, and have since joined different organizations in various parts of the world.

In this dissertation, I hope to have represented some of these conversations, mostly by concentrating on points of contestation, tension and disagreement, thereby spotlighting the unresolved, uncertain, and unknown elements of the Masdar project in particular, and of emergent renewable energy and clean technology infrastructures in general. Besides documenting the production of the Masdar project, I hope to have contributed to the sustainability debates by calling for a celebration, rather than obfuscation, of such instances of indeterminacy.

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